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ABSTRACT

This document presents papers and discussions from an OECD-sponsored conference of international experts on forecasting and planning techniques. The 15 papers discuss the need for planning and its relationship to some major feature of society such as technology, information systems, organizations, government, or social change. In addition to commentaries on the conference by eight respondents, this volume contains the Bellagio Declaration on Planning, a document endorsed by all participants, which emphasizes the necessity of planning in the creation of a future society. (RA)

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ERICH JANTSCH

PERSPECTIVES OF PLANNING

PROCEEDINGS OF THE OECD WORKING SYMPOSIUM
ON LONG-RANGE
FORECASTING AND PLANNING

BELLAGIO, ITALY 27TH OCTOBER - 2ND NOVEMBER 1968

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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The Organisation for Economic Co-operation and Development was set up under a Convention signed in Paris on 14th December 1960 by the Member countries of the Organisation for European Economic Co-operation and by Canada and the United States. This Convention provides that the OECD shall promote policies designed:

- *to achieve the highest sustainable economic growth and employment and a rising standard of living in Member countries, while maintaining financial stability, and thus to contribute to the world economy;*
- *to contribute to sound economic expansion in Member as well as non-member countries in the process of economic development;*
- *to contribute to the expansion of world trade on a multilateral, non-discriminatory basis in accordance with international obligations.*

The legal personality possessed by the Organisation for European Economic Co-operation continues in the OECD which came into being on 30th September 1961.

The members of OECD are Austria, Belgium, Canada, Denmark, Finland, France, the Federal Republic of Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States.

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FOREWORD

The influence of technology in relation to the development of the economy and of society has been a concern of OECD for some years and particular attention has been given to the conditions which favour or discourage technological innovation. Aspects of this problem which are proving of increasing interest to the Member countries include those of the management of large and complex technological systems and the desirability of assessing technological trends through long-range forecasting. A detailed survey of the methods of technological forecasting published by the Organisation has been widely discussed both in industrial and in governmental circles, not only in the OECD area but throughout the industrialised countries of the world.

In continuation of this work OECD and its Science Policy Committee decided to organise discussion on forecasting and planning techniques between a limited number of outstanding scientists who had contributed to the development of new concepts in the field or who, as practitioners of such planning and forecasting, had novel and relevant experience to share. Some twenty leaders in the field were therefore invited to contribute papers on their work and methods and, once these had been received, to meet together to discuss the development and significance of the various approaches. It was hoped in this way to make available through a publication much experience and new thinking which might be of use eventually to the governments of the Member countries, their experts and industrialists.

The discussion took place from 27th October to 2nd November at the Villa Serbelloni, Bellagio, Italy which had been generously made available by the trustees of the Rockefeller Foundation to whom we are particularly grateful.

The papers and discussion represented a wide and practical experience of planning and forecasting methods on topics and situations in which technological, social, economic and management have an important role, and interacted the one with the other. It is apparent that a corpus of knowledge is developing rapidly on these wider aspects of planning, that both technological and social forecasting are desirable, but that as yet there is no general agreement as to the validity of individual methods and techniques. There was, however, a general conviction that the evolving techniques of planning and forecasting have a deep significance in attacking many of the problems now facing our society, and that individual and social aspects must be given greater weight.

The present volume includes a general declaration agreed by all the participants, an impression of the content of the meeting by Dr. Erich Jantsch, who had organised it, the original papers as well as subsequent reflections by some of the authors. It is hoped that its totality will give some indication of the present state of development of this important but difficult subject and of its possible relevance in our technology dominated societies.

THE BELLAGIO DECLARATION ON PLANNING

We, the participants of the O.E.C.D. Working Symposium on Long-Range Forecasting and Planning, having discussed the importance which the subject may have at the present stage of social crisis, feel compelled to put forward our views on the potentials of planning as a method of approach to solving many contemporary problems.

Social institutions face growing difficulties as a result of an ever increasing complexity which arises directly and indirectly from the development and assimilation of technology. Many of the most serious conflicts facing mankind result from the interaction of social, economic, technological, political and psychological forces and can no longer be solved by fractional approaches from individual disciplines. The time is past when economic growth can be promoted without consideration of social consequences and when technology can be allowed to develop without consideration of the social prerequisites of change or the social consequences of such change. Diagnosis is often faulty and remedies proposed often merely suppress symptoms rather than attack the basic cause.

The quality of individual life and that of the community is changing rapidly and in many senses deteriorating; foreseeable technological developments will have a still greater influence, presenting both opportunities for a richer life and attendant dangers.

In the corporate environment, the individual enterprise tends to become larger and more complex. Multinational industrial activities are developing which can be expected to influence increasingly political relationships between the nations. This necessitates international planning.

Complexity and the large scale of problems are forcing decisions to be made at levels where individual participation of those affected is increasingly remote, producing a crisis in political and social development which threatens our whole future. It is in relation to this crisis that we feel the planning function and related arts such as forecasting assume new significance.

Having discussed the present state of the art of planning and the diversity of its new approaches we believe that its possibilities including the appreciation of human values transcend mere technocratic objectives. Scientific attack on these problems of complexity and interdependences is a matter of the utmost urgency, and whilst we have what we consider to be a healthy divergence of views regarding the pertinence and scope of individual method and approaches, *we are nevertheless convinced that a corpus of knowledge already exists capable of immediate exploitation, and that there is expectation of further and fruitful development.*

The need for planning is not generally recognised. Further, the pursuance of orthodox planning is quite insufficient, in that it seldom does more than touch a system through changes of the variables. Planning must be concerned with the structural design of the system itself and involved in the formation of policy. Mere modification of policies already proved to be inadequate will not result in what is right. Science in planning today is too often used to make situations which are inherently bad, more efficiently bad.

The need is to plan systems as a whole, to understand the totality of factors involved and to intervene in the structural design to achieve more integrated operation. All large, complex systems are capable of some degree of self-adaptation. But in the face of immense technological, political, social and economic stresses, they will have to develop new structures. This can easily lead to grave social disturbances if the adaptation is not deliberately planned, but merely allowed to happen.

Recognition of such facts leads us to specify a number of operational conditions which must be satisfied if planning is to evolve its coherent, creative and useful features. In particular :

1. *The scope of planning must be expanded to encompass the formulation of alternative policies and the examination, analysis and explicit stipulation of the underlying values and norms.*

2. *Planning must cope with new situations and devise new institutions. New possibilities of quantitative analysis and simulation of complex dynamic systems using the computer greatly extend our capabilities in this direction.*

3. *Social and institutional experiments, carefully designed and evaluated, should be promoted to develop a better basis for planning and its implementation.*

4. *Planning must be understood in relation to the consequences and in particular the consequences to the individual of decisions and actions within social systems. It should therefore be performed at the lowest effective level to make possible a maximum of participation in the planning itself and in its implementation.*

5. Planning must nevertheless be undertaken simultaneously at different levels and must be integrated across these levels.

These views and recommendations are expressed in response to trends that are irreversible and world-wide in their consequences. We believe therefore that they are urgent and relevant irrespective of political, social and economic ideologies.

The difficulties if ignored will not disappear. We take it upon ourselves therefore to issue this collective warning that social and technological developments already clearly foreseen can exacerbate matters beyond any hope of peaceful relief. In doing so we express the belief that a basis of remedy already exists to help man to define and create his own future.

Bellagio, 2 nd November, 1968.

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SYNOPSIS OF PAPERS AND DISCUSSIONS

Ambitions

An account of the content of the papers and of the discussions will of necessity be highly subjective and critical. The original objective of the Symposium, to integrate thinking – the basic philosophy of approaches as well as their technical aspects – and cement something which might have been called a "platform for the new planning", was not attained in an explicit way. Nevertheless, a considerable degree of clarification was reached with respect to the scope of long-range planning and the profound changes in scope, tasks, and techniques it brings to the planning sciences in general. The Symposium focussed on this innovative end of the problem spectrum. Conventional short-range planning – which, as tactical or operations planning, now forms the lowest level of the integrated new approach to planning – and related arts, such as econometrics, were deliberately excluded from the papers as well as the discussions.

The failure of the Symposium to become fully integrative and thus to achieve one of the main purposes for which it was designed, may be attributed to divergences in terms of personal temperament rather than in terms of the fundamentals underlying the new kind of planning. As soon as the Symposium split into two or three discussion groups – which it did for approximately half the total time – convergence took place in themes (in spite of the assignment of different problem areas to the split groups) and in the views expressed. To state this during the Symposium was considered unfair – and, as a matter of fact, when doing so, the writer of these lines was quickly expelled from the tournament which the brave knights in the glittering armour of their partisan intellectual arguments were determined to fight out. To state now – as proposed in this synopsis – that the Symposium did, in the end, discuss little more than a fraction of the topics already well defined and analysed in the papers and did, quite unwittingly, endorse most of the formulations expounded by them, will be felt as a stab in the back by quite a few of the principal antagonists.

The Symposium, as can be readily seen, was a most exciting and stimulating affair. It fluctuated between individual competition and collective learning and certainly evaded any planning devised to achieve a synergistic effect. In aspiring at modes and levels of perception going beyond those represented in the pre-planned contributions, it fell slightly short of the degree of sophistication, clarity and precision achieved in the series of papers. The predominance of *"orderly" and converging output thus established for the entire enterprise makes it possible to attempt a synopsis which places emphasis on the surprising degree of consensus and even synergy which, after all, did emerge from it (1).*

The papers which were commissioned before the Symposium, and still constitute its principal output, were planned in such a way as to form a stimulating and broad-based "mosaic" of recent and current developments pertaining both to the fundamentals and to important methodological approaches of the "new" kind of planning. At the same time, reading them in the order proposed in this volume will make it possible to follow an itinerary linking logically some of the focal themes and problem areas of planning.

Papers

The itinerary, inherent in the order in which the papers are presented here, will be briefly sketched in this chapter. A number of essential arguments, put forward in the papers, will be confronted in the subsequent two chapters with points raised in the discussions.

The introduction by Salvador de Madariaga, *"Planning for Freedom", evokes some of the principles to be followed by planning if it is directed towards the maintenance and increase of human freedom in the context of social systems. In particular, social systems are set in analogy to living organisms, a notion implicit also in several of the more technical papers.*

A first group *of papers deals primarily with* fundamental problems of planning.

Hasan Ozbekhan, *in his paper "Toward a General Theory of Planning", develops the basic philosophy underlying our present concern with planning, gives a taxonomy of the "new" planning, emphasizing its normative aspects, and discusses the implications of orienting planning towards future high-level goals (anticipations) and dynamically changing human values.*

René Dubos, *in "Future-Oriented Science", states the implicit predominance of social criteria for scientific developments in the past and asks for their explicit stipulation in the future.*

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(1) The generally agreed, and signed, consensus forms part of "The Bellagio Declaration on Planning", which also appears in this volume. Anything which goes beyond this, is interpreted and presented here under the sole responsibility of the author of the synopsis.

Erich Jantsch, *in "Integrative Planning of Technology", proposes the structuring of technological planning in the light of the joint systems of which technology is a constituent – the society/technology, man/technology, and Nature/technology systems – and discusses the possibilities of integrating planning horizontally (system-wide) and vertically (tactical, strategic, and policy planning), essentially in terms of Ozbekhan's taxonomy.*

A second group *of papers discusses methodological inroads to* strategic planning, *thereby dealing with the comparative evaluation of alternative ways to achieve specified outputs, or even outcomes in a systems context.*

The model which Robert H. Rea *exposes in his paper "The Design of Integrated Technological Forecasting and Planning Systems for the Allocation of Resources", constitutes an attempt to combine selected sub-techniques and sub-routines in such a way as to integrate the complex forecasting and planning process from technological forecasts all the way through to recommendations concerning resource allocation, in other words, questions of choice and priority ranking. Although flexible in its application, this model is "tailored" primarily to aid strategic decision-making, i.e. compare the contributions various technological developments can be expected to make towards a strategic goal such as a specific desired outcome of technology in a social system, or a market, etc.*

The paper by Jay W. Forrester *on "Planning Under the Dynamic Influences of Complex Social Systems" is the first attempt of an application of the original "Industrial Dynamics" concept (developed by Forrester and his co-workers over the past decade) to complex social systems – defined here as high-order, multiple-loop, nonlinear, feedback structures within society. The extraordinary potential, inherent in this approach, to simulate – with the help of computers – dynamic systems behaviour characterized by long-range cause/effect relationships that escape any "intuitive" grasp, is demonstrated by examples from a recent study of the city and the conditions for its growth, stability, and decay.*

David Novick's *paper on "Long-Range Planning Through Program Budgeting", finally presents the fundamental ideas incorporated in the output- and outcome-oriented PPBS (Planning-Programming-Budgeting System) which, in the United States, has become the major agent for the abolishment of the input-oriented type of government planning, and its replacement by a formal procedure which encourages a long-range view into the future. The experience of the US Department of Defense since 1961 is summarized in an Annex by* Alain C. Enthoven.

A third group *of papers relates to the level of* policy or normative planning, *at which criteria and goals are established for a rational selection of "good" strategies. Planning at this level involves consideration of the total environment affected by planning, and penetrates into the areas of human value dynamics, human and social goals, and the quality of life.*

Theodore J. Rubin, *in his paper "Toward Information Systems for Environmental Forecasting", sketches possible ways of formalizing and processing information input from the environment so as to provide a rational basis for policy decisions. The EIS approach described is geared to the needs of purposive organizations, in particular industry.*

The paper "Political Information Systems" by Ithiel de Sola Pool *discusses the same problems at the level of society itself – a pluralistic society – and points out new ways to aid policy planning at government level. In particular, it deals with the new capability, introduced by feasible (though not yet realized) computerized information systems, to organize and make use of information pertaining to multivariate complex systems, such as social systems.*

Dennis Gabor, *in his paper on "Open-Ended Planning", puts forward original and new ideas of how to break out of the growth syndromes embedded in the concepts of the post-industrial and consumer societies, and attack the "vital" problems establishing themselves at the level of society in an imperative way. In a mathematical part, he investigates the consequences to be derived from the stipulation of open-ended planning, if the latter means planning with a view towards ensuring the maximum degree of freedom for the next generation of planners.*

A fourth and last group *of papers, finally, deals with* organizational and institutional aspects of planning – *the design of structures which are both required for, and made possible by the new kind of planning. The concept of stability in an environment of rapid change guides considerations in this area to a large extent. The first two papers even aim at some homeostatic self-adaptation of an organization to changing external and internal conditions, thereby stressing the essentially cybernetic character of long-range planning.*

H. Igor Ansoff and Richard G. Brandenburg, *in their paper "A Language for Organization Design", develop an organic classification of concepts for purposive organizations, in particular industry, and search for a framework that will permit their integration. A first approximation is given in the paper, based on a simple L–L (Line Responsibility - Logistic) approach, which lends itself to further refinement in terms of an L–S–L (Line - Staff - Logistic) language, in which the strategic planning functions will become more clearly visible.*

In a paper with the suggestive title "The Aborting Corporate Plan", Stafford Beer *attempts to sketch the structure of the "cybernetic firm" – or any other purposive organization – pursuing the continuous goal of homeostasis in relation to its environment. The five-tier hierarchy of control levels, which he derives as necessary, corresponds in its upper three levels to the notions of planning for policies, strategies, and tactical (operational) objectives, inherent in the concept of long-range planning underlying the contributions to this volume.*

Jay W. Forrester's *paper "A New Corporate Design", the only reprint in this collection, presents a vision of an ultimate degree of flexibility, individual creative contribution, and transparency of objectives at all levels of a purposive organization, again with a particular view to industry. Abolishing the rigid "budget-center" concept and the traditional superior/subordinate relationship, and establishing a "profit-center" concept at the level of individual action, the new corporate design will allow the manager, scientist and engineer of the future the possibility to act and compete as individual entrepreneur within an organization – analogous to the entrepreneur competing today within a free market economy.*

Robert A. Levine, *in his paper "Redesigning Social Systems", elaborates on the important theme of participative planning, involving all systems levels in a flexible and democratic planning process rather than designing rigid administrative structures to implement planning from the top level. The paper considers a number of examples from the United States illustrating the failure of top-level planning, and develops original ideas for participative planning in the framework of the War on Poverty program.*

In his paper "Adaptive Institutions for Shaping the Future", Erich Jantsch *attempts to sketch an evolutionary development from instrumental over pragmatic to adaptive institutions (1) and to discuss its broad implications for structures in government, education, and industry. Augmentation of adaptivity by means of internal organizational structures may already be observed in industry operating in areas of rapid technological change, whereas the combination of institutions in order to respond flexibly to the needs of society – with industry assuming a crucial role – will be a task of the immediate future.*

(1) It should be noted that the papers by Ansoff and Brandenburg, on the one hand, and by Jantsch on the other, give the term "adaptive institution" different meanings. Whereas Ansoff and Brandenburg mean internal adaptivity to new tasks, Jantsch means adaptivity of the response to the environment. Ansoff and Brandenburg's "adaptive form" would belong to Jantsch's "pragmatic" type, whereas their "innovative form" would come very close to the type of organization Jantsch views as being capable of producing adaptive responses to the environment.

Discussions : The Purposeful Design of Systems

The substance of the discussions held during the Symposium may be grouped around two main themes:

(a) The purposeful design of systems;
(b) Structuring planning within a system.

Under each of these main themes, approximately a dozen topics emerged from the essentially unstructured discussions, and moved briefly – most of them also repeatedly – into focus. The following two chapters attempt to relate conspicuous statements in a somewhat logical order to draw attention to relevant points raised in the papers.

The main theme of purposefully designing systems stresses the horizontal integration of planning in a system-wide context.

The dominant concern over systems design, which expressed itself in the discussions, clearly arises from the recognition that planning ought to be integrative, *i.e. cutting across a multitude of dimensions, in particular, social, economic, political, psychological, anthropological, and technological dimensions. However, a certain fixation on social systems – an unnecessary restriction – became apparent and weakened the generality of the statements emerging from the discussions. The first paper by Jantsch, in attempting to structure the tasks of integrative planning, proposes* six basic types of joint systems, *defined by the combination of any two of the following four constituents: man, society, Nature, and technology. In the same paper, it is suspected that some of the most stringent boundary conditions and criteria for integrative planning will be derived from an exploration of the joint systems in which man takes part as an individual. However, the discussions of the Symposium dealt exclusively with two types of joint systems only – the society/technology and the man/society systems.*

This restriction was also borne out by the statement that mankind, in its evolutionary process, is now moving from the era of environmental control (achieved through technology) into the era of social systems, whereas the era of individual systems is still far away – indeed a frightening prospect.

A plea to concentrate on macrosystems and not to waste time with microsystems was also of interest. For many aspects, the macrosystem is now assuming world-wide dimensions and is tending to become identical with an integral world system.

The discussion of systems led quickly to a useful, though not exhaustive, distinction between two basic types of planning:

- The "old" planning, essentially short-range in scope, concentrates on changing variables within a given system.
- The "new" planning, essentially long-range in scope, concentrates on changing the system itself, i.e. its structure as well as its variables.

The first paper by Forrester, dealing with the application of his "Industrial Dynamics" concept to the long-range planning of complex social systems, points out and demonstrates the implications of the "new" planning in a very graphic way. Also his second paper on a new corporate design, as well as the paper by Beer, and the two papers by Jantsch, address themselves to this problem: The "new" planning will include the planning, design, building and operation of systems – and in particular organizations and institutions – in an integral way. This implies that, for example, technological planning will inherently be planning for social change.

It was also noted in the discussions that an organization is an integrated system of coordination, and therefore the easiest thing to destroy by a plan (for example, by changing communication lines).

In trying to understand the current state of our social systems, the discussions dwelt for some time on possible explanations for a paradox which may be formulated as follows: The particular situation, or systems state, in which we find ourselves today, is characterized by the necessity for planning on the one hand, and by the reluctance of the system to accept planning, on the other. This paradox seems to be a basic feature of the majority of social systems today.

It was recognized that the following elements contribute to the necessity of planning:

- Planning responds to higher complexity and is thus a reaction to a failure of the system; the evolution towards a complication of the rules is a consequence of cascading restrictions after restrictions, instead of a changing of the fundamental rules.

- Decisions leading to favourable short-range results, and therefore preferred in our current social systems, will turn out to be bad in the long run; planning is called upon to remedy the situation.

- The progressive variety of the system requires a higher control variety.
- Many growth phenomena in our social systems are approaching limitations or systems boundaries, and therefore need to be controlled.

Among the elements contributing to the rejection of planning by our social systems are the following ones:

- The decision-maker, under high pressure for short-range considerations, cannot understand the planner, who is inherently dealing with the long-run future.
- Planning reveals complexity and uncertainty to an increasing extent; this also inhibits the understanding of planning by the decision-maker.
- The internal power of the system rises to the necessary level to resist change.
- There is a predilection of the public to reach stability in the form of bureaucracy.

All this, in fact, adds little to make the above paradox more transparent. It may well be that Dostoyevsky, in his tale of the Grand Inquisitor, embedded in "The Brothers Karamazov", has already given the most profound and succinct explanation – that man is yearning for freedom, but does not dare to face it.

Today we have the choice between systems in which costs are visible, and systems in which they are not. So far, opportunity costs have been accepted only in times of crisis. It is one of the tasks of planning to make the costs visible also in a long-range context.

Problems of systems structure and thus for the design of systems occupied a considerable fraction of the discussion time. As Forrester points out in his first paper, all complex social systems have an invariant fundamental structure which can be represented by only two types of variables – level and rate variables. Going through a systems model, one always encounters them alternately, never in succession. This fundamental similarity of systems makes it relatively easy to explore the outcomes of changes in the systems structure.

The stipulation of rules about systems design starts from the recognition that the response of the system to the outside is determined by the structure inside the system. If a system is just pushed from the outside, it resists powerfully; the attempt may be compared to pushing a tree.

Forrester's first paper states explicity a number of fundamental rules for changing the internal structure of a system, some of which were also discussed at the Symposium and supplemented by new suggestions. The following were recognized in the discussions:

- Remove causes, not symptoms.
- Do not believe in the "obvious" (intuitive) steps to be taken, which are usually conceived on the basis of suspected short-range cause/effect relationships that may not hold in reality; the simulation of complex systems behaviour frequently demonstrates the powerful influence of long-range cause/effect relationships.
- There are always a few dominant relationships – comparable to dominant genes which determine the hereditary characteristics of living organisms – which may be singled out and which permit decisive systems changes to be made in a relatively inexpensive way. Pool, in his paper, doubts the existence of such dominant relationships in social systems and favours a view of fairly homogeneous influence of multivariate relationships. Alas, this interesting and important question was not taken up as a discussion topic in the Symposium.
- Start building a model which matches current reality. This rule implies building into the model all the disturbances which cause the unsatisfactory development of the system. Then change structure and variables only so as to improve the dynamic behaviour of the system. A counter-argument raised in the discussion favoured building the "ideal" model first and then the system around it. Ansoff and Brandenburg, in their paper, also favour a gradual approach to the "ideal form" in organization design. The matter was not pursued in any detail during the discussions.
- In organizations for which goals cannot be specified, feedback to the consumers is essential. Public organizations, like private ones, can have a market place. The problem of feedback to the outside is also treated in detail in Beer's paper.
- Organizations should be structured so as to offer diverse products and

services, in other words, an alternative utility package. This rule is stipulated in a clearer way in the concept of adaptive institutions designed for a flexible response to the environment, as developed in the second paper by Jantsch.

- *Given a system whose participants pursue a diversity of objectives, the planner ought not to design the structure in detail, but provide for a feedback structure capable of interacting in detail with its environment, and build in a reward system reflecting the adequacy of performing functions. (See also Beer's paper, and especially Forrester's second paper, elaborating on the "profit-center" concept at the level of individual action).*

Very frequently the discussion evoked the prospects inherent in the possibility to design self-organizing, self-stabilizing systems, *a possibility which seems to constitute the only way round ever-increasing complexity in control. The paper by Dubos emphasizes the need for systems in which the endless technology/countertechnology chains, characteristic of the way in which situations are remedied in our present systems, would not have to continue. It was noted in the discussions that to speak of self-adaptive systems would be incorrect here, because, in one way or another, all systems adapt to internal and external changes.*

The discussion of this delicate problem did not yield criteria for clearly defining and judging systems of the self-organizing, self-stabilizing type, or clarify in any way the possibility of designing and building them. The following notions, however, were put forward in the discussions:

- *In order to achieve self-organizing, self-stabilizing systems, a kind of homeostasis has to be achieved in the internal systems structure, not in the response of the system to the outside. The outside-oriented homeostasis, governing the design of a control hierarchy in Beer's paper, can guide only a fully-controlled system.*
- *A self-organizing, self-stabilizing system will never be in an equilibrium; the right kind of disturbances ought to be invented and built into it. In any case, planning does not lead to a stationary state in the long run.*
- *One may suspect that the different modes embedded in a system – e.g. the stagnation, growth, and revival modes – may be viewed in graphic analogy to parts of a system pressing from the inside against the systems boundaries and thus kept in their place by the pressures acting upon the*

boundary from the inside as well as from the outside. Alleviating these pressures would result in letting these systems parts drift away and end up in reinforcing undesirable parts. In particular, it may be expected that the revival mode will drift towards the stagnation mode. The general rule to be derived from this hypothesis is to sustain some pressure on the revival mode (never attempt to realize a pressure-free "ideal" state) and avoid the uncritical alleviation of pressures to go with the "desirable" mode. In Forrester's city model, cited in his first paper, a healthy state is accompanied by some degree of crowding in available housing.

At various phases of the discussion it was asked whether first steps in systems design could be usefully specified. Unfortunately, this problem remained unsolved. The proposed general notion – that a first step which elicits creative response from individuals cannot be wrong – was not endorsed by the majority of discussants.

Two concepts, nevertheless, were mentioned as possible vague guidelines, both closely related to each other: the "expanding island" concept, focussing on the good design of a relatively small system and its subsequent expansion (if it does not fall due to outside pressures, which would indicate its weakness); and the "onion-skin" concept which has been formulated for a staggered regional development of the world (with the advanced Western and Eastern countries forming the inner core, the Mediterranean and Latin American countries the next layer, etc.)

It was noted that the task force approach is generally useful for changing systems, and it was argued that planning ought now to concentrate primarily on the distribution systems, whereas the production systems are already relatively well planned.

Considerable importance was attached in the discussions to the encouragement of experiments, in particular social and institutional experiments which our social systems generally do not now permit. Change can be tried, and experiments may be expected to become the most powerful change agent.

So far, experiments have been promoted only in the framework of old values, whereas the kind of experiment that leads to changes in the system depends on the conception of new values.

A taxonomy of purposive organizations, operational systems, and institutions is already attempted in the paper by Ansoff and Brandenburg, and, to some extent, in the second paper by Jantsch. The value of such a taxonomy has to be seen primarily in the aid it gives to the design of systems.

The nomenclatures used by Ansoff and Brandenburg on the one hand, and by Jantsch on the other, correspond as follows:

Ansoff and Brandenburg	Jantsch
Functional form	*Instrumental institutions (resource-oriented)*
Divisional form	*Pragmatic institutions (output-oriented, pushing linear development)*
Adaptive form (inferring internal adaptivity to new tasks)	*Advanced types of pragmatic institutions (incorporating project management)*
Innovative form	*Adaptive institutions (inferring adaptivity in their response to the environment; outcome-oriented, flexibly introducing non-linear changes and viewing them in a system context)*

Whereas Ansoff and Brandenburg are mainly interested in the phenomenological variety to be observed today, Jantsch emphasizes the evolutionary aspect leading from instrumental over pragmatic to adaptive institutions.

The discussions added the following distinctions to a taxonomy of operating systems:

- *There are two types of systems: homogeneous systems (following a homogeneous set of high-level objectives, as it is found in corporations), and heterogeneous systems (following a plurality of objectives, as it is found in government). One may be permitted to add here that this distinction – if it exists at all – is becoming increasingly blurred today, and is pointless once the "new" planning, integrating the policy, strategy, and tactics (operations) levels, has been established.*
- *There are five basic structures in operating systems: (a) Process and work components, (b) Control systems; (c) Resource allocation system; (d) Information system (relates the operating system to its environments); and (e) motivational system. – Again, these are distinctions holding at best for conventionally structured institutions, and becoming dissolved by the full-scale "new" planning.*

Useful additions to the taxonomy of systems may also be found in the reflections which Ackoff contributed after the Symposium, and which appear under the title "Institutional Functions and Societal Needs" in the last part of this volume.

The requirements for new types of institutions, *and their implications for the task of actively shaping the future, are outlined in the paper by Dubos, and the second paper by Jantsch. A special case is enunciated in Forrester's second paper on the new corporate design. Whereas instrumental institutions are characteristic for the absence of full planning, pragmatic institutions (geared, for example, to mission-oriented research and development) have become the vehicles for the tremendous acceleration of technological and social change. It is the emerging type of adaptive institutions, and inter-institutional combinations, however, which will permit a flexible response to the environment and the design of the joint systems of which society is a constituent. Whereas this latest stage of the evolution is already becoming visible in advanced-thinking industry, and is coming into focus in the American discussions on university reform (in which Europe is just about to make the move from the instrumental to the pragmatic university), a beginning has been made in government by the introduction of the Planning-Programming-Budgeting System (PPBS) which is outlined in Novick's paper.*

The discussions, alas, never arrived at a sufficiently clear view of institutional requirements for carrying out and implementing planning in the fullest sense. There was hardly any recognition of evolutionary trends or of norms for new institutions coming out from the discussions. Thus, the opportunity has been missed to explore Europe's unique chance to move from predominantly instrumental institutions directly to adaptive institutions, without taking the dangerous and unnecessary detour over pragmatic types which the fixation on the American example would suggest in so many areas today – especially in the reform plans for industry and university in Europe.

Discussions: Structuring Planning Within a System

The second main theme of the discussions, namely how to structure planning within a system, stresses the need for the vertical integration of planning. It is more directly concerned with the planning process itself, the same process which, of course, may result in changing the system. The important point, however, is the recognition implicit in the "new" kind of planning, that such changes have to be planned and implemented inside *a system, not imposed from the outside if they are to be effective.*

The hierarchy of planning levels *constitutes a topic on which an impressive convergence of views may be found in the papers, especially those written by Ozbekhan, Beer, Ansoff and Brandenburg, Forrester (second paper), and Jantsch (first paper). It is best expressed by the basic three-level concept of policy (normative) planning, strategic planning, and tactical (operations) planning. If Beer, in his paper, presents a five-tier hierarchy, the same planning levels correspond to the upper three tiers, whereas the two lowest tiers deal with the control of action, and action itself (the implementation of plans). On the other hand, the distinction between two levels of activities in organisations — resource-oriented "doing" activities and goal-oriented "controlling" activities — which was the meager result of a lengthy discussion period, apparently boils down to the distinction between tactical and strategic levels.*

The notion that all systems seem to be embedded in a meta-system, led to the question of where to make the cut in defining and building systems in the meaning given in the preceding chapter. It was proposed that, (a) the inferred hierarchy of systems and meta-systems applies to control levels and thus forms a hierarchy of goals and objectives rather than of physical parts of real systems; and that (b) all those planning and control levels should be embraced by the systems boundaries, which interact with other levels in feedback loops. Thus, the higher planning levels within a system do not just absorb and reconcile the pluralistic lower-level objectives — "act like a sponge", as it was put in the discussions — but involve all levels in the formulation of overall systems goals and their modification in the light of individual claims.

Beer's paper elaborates on the necessity of planning in a time continuum, *not for specific time-frames. In the discussions, it was also noted that the time compression effect of planning implies a continuous movement towards higher systems orders.*

Detailed aspects of the vertical integration *of planning are treated in a number of papers, especially those written by Ozbekhan, Jantsch (first paper), Rea, Ansoff and Brandenburg, Beer, and Forrester (second paper). In particular, this task comes into focus in Rea's model combining various forecasting and planning techniques to integrate the process whose output is recommendations for resource allocation, and in Ansoff and Brandenburg's language for organization design, permitting the integration of various organizational and planning concepts.*

As has already been mentioned in the preceding chapter, planning reveals to an increasing degree the complexity and uncertainty inherent in reality. Thus, planning itself is confronted with ever more complexity and uncertainty. It is impossible to simplify reality by planning. However, planning may be used to fragment the planning task for a system, and also, in configuring preference, it opens up a new dimension from which to introduce new structural principles into the planning process. Strategies, in this context, may be seen as optimally arranged configurations of preferences.

The relationship between planning in a system and environmental change is dealt with in several papers, in particular in those by Beer, Rubin, Pool, and Jantsch (first paper). Beer's principle of external homeostasis – a system adapting itself directly to changes in the environment – did not go unchallenged with those discussants who believed exclusively in internal homeostasis (and would rather place all effective disturbances inside the system than allow for their battering from the outside). Although this problem was never neatly resolved in the discussions, it may turn out to be not much more than a matter of definition.

The environmental information system approaches developed by Rubin and Pool were never discussed in detail. However, it should be noted here that they constitute an important start in organizing information inputs which are required, above all, at the level of policy planning.

Relatively little attention was paid in the discussions to the philosophies underlying the concepts of normative planning and of inventing the future – as distinct from the conventional planning task of solving problems. The reader of the papers, however, will find numerous contributions to this question in practically all the papers.

An interesting discussion topic was found in the new types of competition, which planning brings into play. Emphasis will increasingly shift from competition on the basis of products and processes to competition of ideas, plans and designs. This trend will become the more conspicuous, the more planning will deal with the invention, design, and operation of large-scale systems of which society is a constituent. This will be the foremost task of the adaptive institutions outlined in the second paper by Jantsch. A particulary fascinating concept of this future type of competition is developed in Forrester's paper on the new corporate design with its "profit-center" concept at the level of individual action.

It is evident that competition in terms of plans and ideas for systems –

especially social systems — will add considerably to the blurring of the dividing line between public and private (corporate) planning, *which has become noticeable already in the present. The introduction to governmental planning of the Planning-Programming-Budgeting System (PPBS), outlined in Novick's paper, marks a decisive step in the direction of involving all parts of society — and, in particular, those parts organized in industrial and business corporations — in the planning for society.*

Progress in this direction is so far hampered by the lack of a generalized social cost/effectiveness *approach or technique, which would permit the comparison of plans and designs from the point of view of their effectiveness in a social system. This important methodological gap, although evoked in the first paper by Jantsch, did not come up in the discussions. What cost/effectiveness did in a military context is briefly outlined in the paper by Novick, and its annex by Enthoven.*

Both the papers and the discussions left little doubt about the fundamental cybernetic character of long-range planning *which contrasts with the point-to-point approach of conventional planning and its pursuit of rigid and clearly defined objectives (as tactical planning does in the wider framework of the "new" planning). The title of Beer's paper — "The Aborting Corporate Plan" — states the cybernetic aspect of planning in a suggestive as well as succinct way.*

Planning, it was said in the discussions, ought to concentrate on the dynamics of continuity *— not on growth or on equilibrium. Goals should be stated not in absolute terms, but in terms of rate of change. "Good" planning will then strive for* dynamic stability. *Recognition of this aim becomes particularly important where planning inherently acts as an agent for turmoil, arousing hopes too soon. It may already be observed today that riots do not spring from conditions prevailing at a low level of stagnation, but from improvement. It is not despair, but hope jumping ahead of the possibilities which will be the primary factor in upsetting dynamic stability in many areas of planning.*

The task of setting goals in dynamic terms inevitably requires some estimation of value dynamics. *Human values are not invariant. But, at the same time, it is impossible to forecast future values and ideas. Since planning has to be acted out in the present, norm creation has to be both rational and imaginative. To strike a useful operational balance is a delicate task of long-range planning. It is made even more difficult if we adopt the principle of "open-ended planning", evoked in Gabor's paper, aiming at leaving the* *maximum degree of freedom for the next generation of planners. One of the consequences to be derived from Gabor's mathematical treatment of the problem is that maximum freedom should be pursued in such a way that it is never completely reached; maximum freedom would imply immobility because, once attained, any new "free" move would lead to less freedom.*

In spite of the dynamic nature of planning, the discussions also tried to define something like a general image to guide our concepts of the future — our anticipations, *as Ozbekhan calls them in his paper.* "Ecological balance" *was proposed but, although this term seems capable of embracing quite a few of the other notions concurring with the scope of long-range planning — dynamic stability, self-organizing and self-stabilizing systems, internal and external homeostasis, etc. — it never became clearly enough defined in the discussions to become really useful. Ecological engineering, suggested in the first paper by Jantsch as the ultimate aim of the integrative planning of technology, can be better grasped as a mode of planning and human action.*

At this stage of summarizing the discussions a few of the definitions of planning, *put forward in the discussions, may be recorded:*

- *Planning is a goal-directed decision-making process (a definition originally proposed by W. Churchman);*
- *Planning is the formalization of the factors involved in determining the goals and the establishment of the decision processes to achieve these goals;*
- *Planning is the making of models of causative anticipations;*
- *Planning is the systematic enrichment of the information base for decision-making (pointing out consequences for the future of alternative courses of action taken in the present, and consequences for present action of alternative goals in the future).*

The first three definitions lead to a more or less complete identification of planning and decision-making, *the last definition emphasizes their clear separation. Nevertheless, there was a certain consensus that planning essentially deals with the long range (including changing the systems), and decision-making with the short range (within given systems) — whether there be a clear separation or a continuum between these two poles. In his second paper, Forrester points out that at least tactical planning and decision-making can be entrusted to the same individual, provided that there is a clear and explicitly stated policy.*

Generally, planning was recognized as becoming more and more the scientific side of the social sciences and was sometimes even coming close to being identified with political management. The paper by Pool elaborates on the growing importance of planning — and of computer capabilities — for the social sciences.

The second paper by Jantsch summarizes the essential features of the "new" kind of planning *as follows. Planning ought to be:*

(a) Integrative (dealing with systems cutting across social, political, economic, psychological, anthropological and technological dimensions);

(b) Normative (oriented towards goals and establishing preferences);

(c) Adaptive (or even cybernetic — continuously modifying goals and preferences);

(d) Democratic (based on the principle of decentralized initiative and centralized synthesis — thus eliciting creative responses from all levels of planning and of participation, and integrating them);

(e) Not responsible for decision-making (but preparing a richer information base for decision-making through the comparative assessment of alternatives in a homogeneous and impartial way).

Whereas there was, implicitly, good agreement on the first three points above, temperaments and ambitions split drastically over the last two points. It was particularly interesting to watch those discussants who spoke loudest for democracy in planning, *insist, at the same time, on the identity or near-identity of planning and decision-making. The* "New Ptolemaeans", *thus staking their claim, will make it difficult to explain the essentially non-technocratic aspirations of the "new" planning in a convincing way. Too few of the planners are yet prepared to follow De Madariaga's appeal: Planner, plan yourself.*

The papers by Beer, Gabor, Forrester (second paper), Jantsch (second paper), and particularly the paper by Levine, all deal with aspects of democratic planning. In the discussions it was noted that the present trend towards participative democracy arises from the feeling that the possibilities for the future have been foreclosed. Planning is called upon to open up new possibilities.

In the discussions, considerable emphasis was placed on the necessity to plan at the lowest effective level – *although this represents a rather fractional view of the entire planning process which, of course, unfolds integrally over all participating levels. The necessity to take all social planning directly to the people, and the impossibility to do so because of the time-lags involved, finally led to the discussion of leadership.*

Leadership *does have the effect of collapsing time. It provokes a quantum jump. Leaders invent futures which they may not have planned and thereby create the feeling that there are new possibilities open in the future. Certainly, leadership is related to the built-in possibility of experimentation within a system.*

There was no agreement as to who should be called a leader – the carrier of new and inventive ideas, or somebody who merely opens a valve and brings the potential of a given situation into play.

What planning in its fullest meaning stands for, however, was borne out by the Bellagio Symposium and expressed by the opening remarks of Aurelio Peccei: *Even if we have the forecaster, the planner, and the decision-maker, we still need the* "inspirer" *to give life to the arts and sciences of planning and to orient them towards the supreme goal of creating our own future.*

An Idea: The Advanced Institute for the Planning Sciences

In the final phases of the discussion it was suggested that the best way to advance the state of the art of planning would be the creation of an Advanced Institute for the Planning Sciences. Such an institute might be modelled after the already existing Advanced Institutes for the physical and the behavioural sciences.

The envisaged planning institute might focus on central themes, changing them every year or every two years. These central themes would be elaborated through the interaction of three types of residents: (a) six to twelve outstanding scholars, bound to the institute by a one- or two-year contract; (b) residents for one to three weeks, serving mainly as "information sources" (politicians, company presidents, etc.); and (c) visitors, staying for one to three days, and being invited to conduct seminars.

Intrigued with the specific quality of life they found in Italy, the participants of the Bellagio Symposium – and, in particular, the American contingent – were unanimous in favouring a location in Italy, possibly near Rome.

With more emphasis on actual studies related to system-wide planning of world scope, such a planning institute would approach ideas which are "in the air" and have so far crystallized in two proposals for a joint set-up by the industrialized countries (East and West). At national level, the "Institute for the Future" of the type just established in the United States also takes an active interest in developing planning and its related arts – especially technological and economic forecasting.

An alternative mentioned, but not nearly so good, would be a "clearinghouse for Experience in Planning", which could function in a highly automated way.

Erich Jantsch

Part One

CONTRIBUTIONS TO THE SYMPOSIUM

INTRODUCTION

PLANNING FOR FREEDOM

by

Salvador de MADARIAGA[1]

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The core of the trouble in planning was best brought to the light not by an economist or a sociologist but by a novelist who was, of course, a poet. Unamuno tells of a young man who, feeling he was ripe enough to choose a wife, set about to find his mate in a truly scientific fashion. He wrote down a thorough analysis of his own self, body, mind and soul ; then a similar analysis of the perfect Spanish citizen it was his duty to procreate ; and finally, by composing those two premisses, an analysis of the wife he was in duty bound to choose. This done, he cries out : But that is exactly Miss So-and-So. Blonde, brachycephalous, tall, well covered with shapely flesh, blue-eyed, a milk-white complexion...—the very thing. He folded his paper, put it in his pocket and at once left for the paragon's house to put his obvious plan to her.

He ran downstairs from his flat and stood at the street door. Raining. Shall I run upstairs again for an umbrella ? While he hesitated, he heard the neat, repeated knock of light footsteps on the wet pavement. He looked round. A young woman was approaching ; struggling against wind and rain so that all the umbrella allowed him to see of her was two thin, elegant legs and two impertinent little feet. How delightful, he thought. He followed her, on and on, getting angrier and angrier with himself. Why. She is dolichocephalous. Her hair is dark, downright black. I bet her eyes are black. She's as thin as they make them. The very opposite of what I wrote down in my paper. It is really absurd. On he went. Absurd. She turned a corner. Absurd. He followed. He went upstairs. Absurd. He proposed. Absurd. He married her.

Thought versus life. Geometry versus nature. Spheres versus potatoes. Cylinders versus sticks. And beyond those contradictions in mere space, the even more intractable and complex contradictions in time, caused chiefly by growth and the unexpected. *Gouverner c'est prévoir.* And Napoléon used to say : *Il faut faire la part de l'imprévu.* But how can one be sure that *l'imprévu* will be content with the share we have set aside for it ?

It is this fundamental contradiction between thought and life, between foresight and the unforeseeable that the planner feels at every turn as his chief obstacle. The two components enter into sociology in the form of statistics and psychology in a way not unlike the physicists' twofold approach to the atom, through either the wave or the particle. The behaviour of great numbers of human beings lets itself be ruled by statistical laws ; but every one of the individuals that perform these acts obedient to mathematical formulas behaves in an unaccountable way. The number of suicides in a city or of railway passengers between two cities may follow fairly foreseeable curves ; but the causes for the suicides or the railway trips are individual and rebellious to a statistical study ; in fact, unknown.

Now this rebellion of life against statistical law may in some cases dramatically alter the mass movements on which these laws are established. We have all heard about that length of Cleopatra's nose and that stone in Cromwell's bladder ; and who can forget those sinister bullets that put a stop to the lives of Franz-Ferdinand, the two Kennedys ? At times one man's creative will can deflect the river of history at its mightiest : thus Columbus twisting from South to West the pent-up energies of Spain ready to overflow and invade the Islamic Crescent with Christian force in a hit-back movement that would have fundamentally altered the history of man.

No historian of town planning, by the way, can afford to overlook the laws of the Indies in which " a whole chapter is devoted to the placing of cities and their mapping bearing in mind what we should to-day call socio-economic factors... It was then that urban engineering was born, so that these Royal Orders became in fact the first planning law that was ever enacted. " (1) Any tourist can see the outcome of this planning law in the similarity, indeed, the identity, of every old Spanish city from Texas to Patagonia ; but the important point here is that Philip II's ministers were planning a new world, which they were creating, if not altogether *ex-nihilo*, at any rate for a few thousand Spaniards as the governing class of a few million passive Indians. Space was vast and time unlimited and the rhythm of activity was slow.

Furthermore, the New World was indeed a world in and for itself owing to the distance that separated it from the centre of human activity, then in Europe. In our day, planning of the most frequent kind takes the nation for its object ; and a modern nation is becoming more and more like a basket in which we endeavour to hold water. Frontiers are vanishing fast, and even the Soviet Union can no longer keep out news and views which pour in through its leaky iron curtain. The drive imparted by technological progress on the evolution of all the nations of the whole mankind towards one single World Community can no longer be arrested.

Such are the conditions under which a modern planner must work. If he tries to imprison life in the straitjacket of his statistical thinking, he is bound to fail. Useful as a tool, statistics can never replace the flexible mind ever open to intuitional revelations. Physicists are aware of the fact that the more they know about the speed of an electron the less they know about its momentum. Sociologists should know that the more they know about the statistics of men the less they know about their psychology. And when planning, therefore, the wider the berth they allow the individual, the nearer they will come to success.

(1) Luis A. Bracamontes, Lecture at the College of Mining, Mexico, 1967 ; cited by : Prieto, Carlos, " La Mineria en el Nuevo Mundo ", *Revista de Occidente*, Madrid, 1968.

Statistics deal with that which is equal in all men ; psychology brings in that which is unique. It is from the unique in man that his creative powers spring ; and, therefore, since no planning is worth the trouble that hinders or bars creativeness, it is on the unique in man that planning must base its philosophy.

This conclusion has been met with while examining the means for planning. It is also valid when planning is being considered from the point of view of its end. For it would be a singular aberration, indeed, if by dint of insisting on planning in order to benefit our community and through it mankind, we were to reduce men to the level of tokens for calculation or switches for a computer. In everything, therefore, we must consider the end.

Now, to give an elementary example, it is obvious that the best form of planning for feeding a city would be an automatic distribution of a nutritious liquid through pipes like those that nowadays bring us our water and our gas ; but not less obvious that no one would accept such a system, since it would reduce human beings to an almost animal level.

Let us pause to consider this, for it is odd. We accept that gas and water should come into our houses in pipes, but not food. Why ? Is it not because water and gas are instruments while food is a finished product, complex, elaborate, sophisticated, *ours,* i.e. created by us ? True water is also food, but it can not be elaborated on. It is a raw material for food. Thus it is plain that what we are protecting when we reject the idea of push-button food is our freedom to create. We are led to a similar conclusion by the scrutiny of the automatic distribution of news, views and impressions we get through radio and television nets. We keep a keen watch on these systems, dangerous to our freedom. This is the extreme form into which the issue can be cast. It raises the problem at the core of our discussion : freedom.

This is not the place for a thorough discussion of human freedom. It must be assumed that we all agree on the primordial claim of freedom so that, even if for the sake of planning some detailed restrictions of freedom were to be consented, no planning would be worth the name that would do away with freedom in itself. This is a different claim from that which made us reject any form of planning that would jeopardise freedom as the necessary condition for creativeness. This time we are rejecting such a planning not merely as unadvisable because it would prove inefficient, but as unacceptable because it would lead to human subjection while our aim is to make men free.

Some planning, of course, there must be, but its nature would change. And, by and large, the change would consist in passing from a mechanical to an organic conception of what is to be done ; not merely on a willingness to accept but on an eagerness to solicit and foster cooperation with the spontaneous forces of life at every level and in particular at that of individual activity. This would not necessarily mean giving up the mechanisation of that sector of collective life that lends itself to it by nature ; but it would imply giving up all attempts at mechanising the far more important sector of collective life that is organic and rejects mechanisation.

The criteria for telling this sector are soon met with and in an easily recognised form. They are quality, difference, interdependence and that supreme criterion of organic life : the presence of the whole in every part.

The planner must realise he is on a wrong track as soon as his endeavours drive him to sacrifice quality to quantity. This is an error the easier to commit for its being in tune with the demagogic trends fostered in our age by mass media and the universal primary education. A horrid word has been invented – *élitism* – in order to excommunicate quality from our societies. This challenge must be met with courage. Quality has two enemies : quantity and equality ; for equality, which, well understood, is a precious virtue of the heart, ill-understood is a knife that levels down the community by cutting off every head above the average.

Statistically or mechanically understood, egalitarianism in fact betrays equality, since it treats different people the same way, and *therefore unequally* ; for if we load equally with onehundredweight loads the hefty docker, the slender intellectual, the woman and the child, that formal equality resolves itself into a factual inequality. In this case, the error is obvious enough ; but in most cases, egalitarianism, though less obviously, is just as unfair. But it does worse than that : it blocks the working of the action of the vertical forces in the community, since it prevents the ascent of the able and ambitious and the descent of the incapable and blunt, each to seek the levels that suit them and to which they are suited ; and this freedom of up and down movement is no less indispensable to the individual than to the community.

Thus the problem of quality merges with that of difference. There is no virtue and no advantage in treating the same way persons who are different. Two men may weigh the same and one may be a brilliant portrait painter and the other one an honest to God mediocre house-painter. If your planning is at the chapter on mechanising the transport of human beings, you can treat them equally, since their weight is the same ; if it goes beyond, they will have to be dealt with differently, since they are different in every thing but physical weight. But of differences between men there is no end in nature ; and insofar as planning would tend to constrain them to a degree of uniformity beyond what freedom tolerates, or, in other words, since differences will not adjust to planning, planning must respect differences. It is from them that the tensions come from which the urge for new things may arise.

Since our planning has a community for its object, it deals with a reality that belongs to organic nature. If we accept, as accept we must, that a nation, rather than the sum arithmetic of its individuals, really is the integration of its institutions, we shall have to recognize in it a certain organic nature. We need not argue whether it is an organism or not ; all we need is to realize that there are ways in which it behaves as if it were an organism. Thus its institutions, no matter how neat they may be, make no sense by themselves in isolation, but only in reference to each other and to the whole. The human liver may be in itself a neat organ but it makes sense only when referred to the other viscerae and to the blood. So the National Bank, and the Law Courts and Parliament. Viscerae in one case, institutions in the other, amount to mere *centres of functional perspective.*

When planning, therefore, we may expect to meet at every step with this closely knit interdependence of institutions, strengthened by the circulation of wealth, objects, persons and opinions through them all as the blood, the nervous currents and other bodily fluids do through the viscerae of the body. We shall soon find that interventions motivated solely by statistical-mechanical considerations will tend to call forth unexpected repercussions in other regions of the body politic. This will recall us to our senses, and induce us to realise that beyond the mechanical aspects of life, planning must seek to stimulate and if possible coordinate, but not to regulate or command, what is there already.

Finally, the planner will have to bear in mind that crowning fact of all life, which of course applies also to collective life : that the whole is present in every part. Every social or economic problem starts waves that shake the political, moral, religious or any other aspect or sector of the community. In fact, an economic problem is but a general national problem seen from an economic standpoint. A statistical-mechanical way of planning may therefore reverberate in ways never dreamt of, let alone desired, by its originators. The plans carefully laid out for attaining full employment, for instance, may produce on the one hand a far reaching and costly revolution in home-building through the disappearance of domestic service, and on the other, juvenile crime and student violence, owing to the weakening of the maternal influence in the home. All sectional or special changes are apt to produce general and universal effects.

This observation would suffice to justify planning from the point of view of the common and general interest. Having established the principle that individual freedom is not merely the most efficient means but the only acceptable end of planning, we must now balance it by declaring that the freedom of the community i.e. its right to be considered as such, is also the best means and a legitimate end of our planning. A synthesis is necessary or a realisation of the fact that order is as necessary for liberty as liberty is for order.

Town-planning is perhaps the best terrain on which to land from such abstractions. Home building began at random, every one as he wished, with no thought ever for streets. The inventor of streets was the first town planner even though little thought was given to their sense or straightness. Sewage and water on tap worked in favour of straight lines. Beauty came later. The serpentines of old cities are picturesque, but the rue de Rivoli, the Place des Vosges, are superb ; indeed so superb that we forgive the town planner for the repression of human freedom those plans inflicted on the owners.

Experience, however, was to show that unlimited private freedom in the matter of building could lead either to the dismal ugliness of some streets which hurt the eye as sample rows of conflicting bad tastes (Brussels for instance) or to an indiscriminate dotting of the landscape by small, insignificant, *petit bourgeois villas* (vicinity of Paris) or to a scandalous exploitation of every square inch of soil for the sake of rent (outskirts of Madrid or Rome). Someone there must be to stand for landscape building, dignified uniformity in streets, healthy use of space, trees, who but the planner ?

This, of course, raises a problem. How to ensure that the planner will adequately incarnate the common interest in all its complex aspects, beauty as well as health, traffic, finance ? There is no answer to this question. Life will provide. It will provide out of its fund, whatever its fund is at that time-space juncture. The idea that such problems may admit of hard and fast, ready made solutions, belongs to that mechanical attitude we are struggling against. The Rue de Rivoli is more admirable from the architect's than from the health expert's point of view. At every point in our progress (in the sense of mere movement) we must expect no more than what we hold in ourselves, man and group.

It would appear therefore that planning should be preceded by a certain amount of *planning of planning*. To echo a classical piece of advice : *planner, plan yourself*. We should plan our plans. We should carefully survey the reality before us to size up its measurable and so to speak mechanical sector, that part of it which would eventually admit of statistical-mechanical solutions , and this done, limit the rigid part of our planning to that sector ; then organise the rest so as to marshall, guide and coordinate the free, spontaneous creativeness of institutions and individuals, allowing for their qualities, differences, experience, traditions, hopes and even, when not uncooperative, prejudices ; thus aiming as best we can at a happy alliance of the craving of thought for definiteness and the no less craving of life for the indefinite and the unexpected : the wall and the rose on the wall.

TOWARD A GENERAL THEORY OF PLANNING

by

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I. THE SITUATION AND THE IMPERATIVE

1.

When I was asked to present a paper to this Symposium on Long-Range Forecasting and Planning, the statement of work mentioned something about the "philosophy of planning" and about going "beyond philosophy to matters of possible action." The immediate need for a title was also indicated, and in the absence of an expression of anything showing a clear preference on my part, I was told that my subject would be tentatively called "The Evolution of Planning".

I have found it difficult to ignore the proposed subject matter, and equally difficult to abide by the suggested title. Although the evolution of planning is of deep interest, it greatly exceeds my competence. I visualize it as an unfolding perspective of occurrences whose relationships are forever in flux. To identify these occurrences, to organize them into meaningful patterns, and to interpret the significance of the forces that have underlain and guided their intricate development is clearly a scholar's work. I, unfortunately, am a scholar neither by background nor by temperament. I am an economist, who, like many economists today, has become a planner. I do planning as a *métier*. I think about it a great deal, both so that I may contribute to its improvement as a discipline and to become a better practitioner.

Since I first embarked on this career, almost fifteen years ago, a great deal has happened in the field. Corporate planning has become an accepted management function. Economic planning supports and guides development in many lands throughout the world. Urban planning is more and more being practised as an interdisciplinary skill that seeks to take into account those complex social problems and needs which will enlarge its jurisdiction. Financial support of planning and related professions is increasing. The quality of professionals engaged in planning is constantly improving. The field has become almost world-wide, and more frequent communication among specialists is encouraging an exchange of opinions and the creation of new approaches that are notably freer than the parochial thinking of earlier days.

So far, so good. Yet, whenever I reflect seriously about planning, I am bothered. I am bothered mostly by the fact that planning is enjoying its vogue without benefit either of a supporting framework of ideas intrinsic to it or even of a small piece of theoretical ground it can claim as its own — something that is part of, yet distinct from, the surrounding culture — and on whose soil one might hope to grow those generalizing and organizing principles, those operationnally verifiable methodologies, those legitimate and discrete applications, that most other serious disciplines possess.

In planning we are not yet blessed with any such normal profundities. Beyond the fact that it involves the future, and that the steps in terms of which it is described must be ordered in relation to some goal for planning, we have neither a general theory nor special theories of it, we have no widely accepted language that communicates its logic, no structure that organizes its predictive or explicatory propositions into an operational model, we do not even have such propositions. In sum, whatever it is that we call *planning* lacks that solid foundation from which it should be possible to strengthen and flesh out, to direct and evolve, to dispute and adjust the *corpus* of the practice itself.

Until recently, in higher military circles the existence of strategy was often denied, because it lacked a hard-based theory that went beyond tautological postulates and individual skill in the field (1). So it is still with planning. Professional opinion remains strongly biased in favor of its tactical components, or special applications, such as Business Planning, Management Science, Organization Theory, Systems Analysis, Planning Programming Budgeting, etc. Yet, again, as in the former case of knowledge about strategy *per se,* knowledge about planning *per se* seems to be greatly needed. As I have noted, never before have we talked so much of plans and planning. Never before has planning been so much in demand or so widely felt as a necessity both in the public sector and in the private. Never before, to my knowledge, have we been so obsessively, and tangibly aware of the future; it is as if the far distant consequences of our actions were already casting long shadows upon the present. To most of us in Western countries it would seem that 1985 or the year 2000 are in some deep and mysterious ways more familiar than the Europe of pre-Common Market days or Eisenhower's America. It is as though mankind – or, at least industrial mankind – were in search of a *coherent light* that it could beam upon the future.

What is it that one must do to build a theoretical basis for planning? What issues need be raised and what issues settled? Would the result be worth the effort in operational terms? And, if we succeeded, what would our success really signify? These and many more such questions are the kind that we must answer. In the following pages I shall try to suggest certain approaches that might permit the invention of some answers.

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(1) For an interesting discussion of this point see: Brodie, B., *Strategy in the Missile Age,*Princeton University Press, Princeton, New Jersey, 1959.

In this effort, I shall try, as simply as possible, to: define the experiential ground from which my central hypotheses derive; propose a philosophical base which will clarify my own biases; describe the central construct of the system in terms that I shall have previously defined. I shall not go, as I should, into questions of evaluation and justification. Nor shall I dwell at the same level of detail on each of the above points. My main effort will be spent on establishing the "philosophical base," hoping as I do, thereby, to be able to satisfy the requirements of this Symposium.

2.

Even a synoptic and spotty statement such as the one I shall attempt has to be so conceived as to hold together in its parts and internal relationships; it should display an acceptable level of logical consistency, and some evidence of operationality in its linkages with the real world – the world of events. We must seek to establish, albeit in the form of an incomplete outline, the foundations of a body of organized hypotheses, in the hope of obtaining new knowledge or new insights from them.

The necessity for this effort appears to me to be grounded in two things : (a) The overall *situation,* in which we find ourselves surrounded by events that look extremely grave, confused, and dangerous – events whose inner dynamics and active consequences we cannot understand without a conceptually created order to which they can be referred. The lack of such a cogent frame forces increasing numbers of people to try to invent, *ad hoc,* an orderly view of our complex world, by the almost frenetic exercise of disconnected kinds of planning, as if the mere activity of planning were a mnemonic device capable of bringing them solace whenever they are face to face with the portentous decisions they have to make. (b) The *intellectual imperative* that trait of the Western mind which dictates that generally shared beliefs or ideas must be organized within a rational mold, and thereby made credible in relation to prevailing modes of perception, as well as in relation to certain basic rules that legitimize the process of rationalization.

However, even before we have so much as taken the first tentative step, the central problem that will dominate our endeavor becomes apparent, for we immediately discover that today the *situation* and the *intellectual imperative* have congealed into a symmetrical mismatch that I am almost tempted to describe as "adversary" in character. The familiar concepts, values, thoughts, and approaches, which until quite recently served to focus our perceptions, to clarify, reorder and relate what is obscure and unmanageable in our situation, are now found wanting. They are no longer able to shake down the present into some comprehensible design; that is, into a design which is meaningful in relation to current happenings. Old methods of observation, analysis, resolution and classification appear to have become obsolete. Our single-valued logic is ill-suited to probe the multi-valued depths of the sense-data we receive; explicatory prediction, on which we have long relied, was not intended to deal with the uncertainties that both nature and society seem to generate through the mere fact of existing, unfolding, and evolving. The cultural referents we had come to view as absolute – liberty, equality, privacy, dignity, the individual, the nation, constitutions, the common good, and so forth – no longer provide automatic guidance to our feelings or to our behavior. Their ultimate, no less than their operational significance is now blurred when it is not irrelevant, and insufficient when it is not confusing.

The prime reason for the failure of the rules and values on which our rationality rests can, as I and many others believe, be found in the massive changes and the rapid rates of change that most Western societies are undergoing. The phenomena generated by change are not only stressful, they are not only disquieting – but they put to question the validity of many general concepts that, for a long time, have provided muscle to our world view. It is admittedly difficult to maintain a world view predicated on a particular definition of facts when we are no longer sure what a fact is, or, on scarcity when we, in the industrially advanced West, are experiencing the birth pains of abundance; or, on the sanctity of toil when the possibility of a leisure society has already raised questions of social organization so fundamental as to be frightening, and so alien to our traditional modes of thinking as to be unanswerable, except perhaps in terms of science fiction – something we do not yet consider wholly respectable. The list could be extended, however, to illustrate my initial premise that the present situation can no longer be rationalized by means of the intellectual constructs we currently possess, and which we have largely inherited from the nineteenth century.

Nor have we even come within shouting distance of putting the situation aright. Whatever has lost its validity has not been replaced by any new or consistent norms. When questions are asked on this subject, the answers one gets are at best simplistic. One is told to "Make love, not war", one is told of "flower power," and of the importance of seeing reality "like it is"; one is told to be "with it"; one is told the work, the rewards, the action, the decisions – especially the decisions – must be "shared." These haphazard injunctions do not amount to a new value system. But they tell us, with desperate insistence, that the situation has changed and that we must recognize this fact.

This, in itself, is extremely important. It has brought to the surface many symptoms such as the loss of the sense of continuity, of logical order and of determinable causal relationships, from which we have been suffering for some time. Andrew Kopkind (1) has recently put his finger squarely on this point:

> "So much is moving and shifting that it is hard to catch more than a glimpse of the action as it passes by. Events tumble upon one another like theatrical happenings, and the sequence of things is lost: Logic is another casualty of political disintegration. In a situation of such fluidity the events themselves have less intrinsic than contextual meaning. Senator McCarthy's good showing in the New Hampshire primary (who remembers that he lost in the popular vote to a write-in candidate ?) and Robert Kennedy's subsequent entrance into the Presidential campaign were thought to have "caused" President Johnson's March 31 speech of retirement and deescalation. But it is dangerous to draw tight causal relationships. Those political events were set in context of the N.L.F.'s stunning Tet offensive and the world gold crisis – which were related phenomena themselves.
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> There is something happening, as Dylan sang, but we don't know what it is, at least not exactly. People are right when they sense something new in their lives, even if they cannot touch it or see it. Sexual freedom, the kids, the riots, assassinations: they all seem to be related, but the bonds are obscure.
>
> To look for the links between those surface effects is inevitably unrewarding. The connections are all underground, in a root mass of rapidly growing and changing new relationships, of men to men and institutions among themselves. For four decades the material basis of American life has been in the process of real transformation, from classic industrial development to the "new system" of postindustrialism, or postcapitalism, or technologism, or whatever it's called. The politics, ideologies, mores and life patterns of the old system obviously cannot work well with the new."

Let me hasten to note that this is not an entirely new experience for Western peoples. In times that may still be considered as recent when seen relative to the age of organized human concourse, a somewhat similar breakdown occurred when the world view of the Roman Empire, together with its political instrumentalities, was shattered and that part of Europe which had been civilized by the Roman conception of polity went through what we remember as the Dark Ages. We came out of that profound disorder of soul, society, and environment, thanks to the powerful organizing and rationalizing principles upheld and imposed by occidental Christianity. More recently still, we went through the Renaissance (an actual *renascence*) whose events and martyrdoms propelled us into a new order of vision, of perception and of behavior, when the already aging Church order had grown unable either to nurture or to warrant the theological and institutional arrangements it, itself, had created. And then the eighteenth century fell upon us with its ferment of ideas, discoveries, novelties, and embarrassing questions building up such a head of steam that before it could close in some semblance of peace, the whole intellectual, social, and political edifice exploded in the face of its caretakers. It was rebuilt piecemeal using the values and techniques, the hastily conceived and blindly adopted blueprints for action that were spawned during the blustery days of the Industrial Revolution — just before massive applications of technology turned those days into the *post*-industrial hurricane ! At present, our perception is still largely governed by the world view of nineteenth century industrialism. Our problem is that the reality we are beginning to sense and with which we must deal belongs, by our own admission, to some other, newer order. It is the rationalizing principles of this latter reality that we are now called upon to define.

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(1) Kopkind, Andrew, "Are we in the Middle of a Revolution? ", *New York Times Magazine*, 10 November 1968.

3.

Planning is too new and raw a discipline, or art, or science, to require us to indulge in a lengthy exegesis to establish the working hypotheses that we need. Tentative ideas of a descriptive character can be derived from observation and substantified by tying them to the main, the salient, elements that make up the context of planning activities.

First, it is obvious that planning is an activity which operates *on* something — an object or entity that is distinct. Second, planning is done or applied to this entity *for* some specific purpose; otherwise it would be in the order of an *acte gratuit*, and would by definition cease to be planning. Thus it is upon the dimensions of this "on" and this "for", of the entity and the purpose, that we might begin by focusing our attention.

Prima facie, it would appear that the objects humans can, or could, subject to planning are as numerous as the objects which make up our immediate universe. They range, say, from the stone which the Bushman plans to convert into an axe-head or a knife, all the way to the most complex social, economic, political structures through which post-industrial mankind plans to achieve whatever it is that post-industrial mankind is supposed to want. Hence for our purposes the term "object" should be defined broadly and made to encompass not only physical things, or human or social structures, but also relations between such structures, interactions among them, processes that occur within and between them, interface phenomena, and, most importantly, human activity guided by intention.

Thus, although the "on" factor in the planning equation is relatively easy to identify in terms of the constituents of physical reality and human experience, the "for" factor becomes more difficult to pin down once planning is seen as encompassing ever greater numbers of combinations into which physical objects, the environment, human activity, attitudes, movement, behavior, thinking, volition, institutions, traditions, procedures, etc., are introduced in the form of changing relationships.

I believe that this observation can perhaps be more clearly and easily dealt with if we say that the "for" of planning grows confused when the object on which planning is applied is a *system*.

The nature of this growing confusion as well as the nature of systems will be dealt with in some detail later on in this paper. Nevertheless, it should make my present task easier if I defined system immediately.

Of the following two definitions, the first one by Hall and Fagen is a classic:

> "A system is a set of objects together with relationships between the objects and between their attributes." (1)

I am, nevertheless, going to quote F.H. Allport's definition also, because it communicates more dramatically the feeling of both complication and complexity that I wish to convey.

The concept "system", according to this writer can be made to refer to

> "....any recognizable delimited aggregate of dynamic elements that are in

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(1) Hall, A.D. and R.E. Fagen, "Definition of System" in *Modern Systems Research for the Behavioral Scientist*, W. Buckley (ed.), Aldine Publishing Co, Chicago, 1968.

> some way interconnected and interdependent and that continue to operate together according to certain laws and in such a way as to produce some characteristic total effect. A system, in other words, is something that is concerned with some kind of activity and preserves a kind of integration and unity; and a particular system can be recognized as distinct from other systems to which, however, it may be dynamically related. Systems may be complex, they may be made up of interdependent sub-systems, each of which, though less autonomous than the entire aggregate, is nevertheless fairly distinguishable in operation." (1)

The "on" and the "for" by which planning occurs must be viewed in relation to this graduated complexity that ranges from the simplest thing to more and more combinations of entities, elements and attributes, and ultimately, to what we shall be calling "complex dynamic systems." So much for the nature of the object and for the two-pronged intervention upon it we have termed "planning". Our next step must be to ask, "Why is this action upon the object necessary? "

The answer that immediately suggests itself is: "To effect a change in the object." But clearly more must be implied in this response than meets the eye, because *any* intervention – quite apart from that we have designated as planning – could bring about such change. Hence our answer has to be modified to read, "To effect pre-intended change in the object." That which distinguishes planning from other "on" acts is, therefore, the attributes, and perhaps even the quality, of prior intentions ; prior intention, in turn, must here refer to the intellective process of designing the outcome of the intervention before any action is taken; it must also mean the intellective pre-designing of the action so that the intended, the pre-conceived, result(s) will ensue.

The above reasoning now permits us to make the following first order definitions and to enter them as initial hypotheses:

a. Planning is to act *on* some object
b. Planning is to act on to act some object *for* some purpose
c. Planning is to act some object for the purpose of effecting *change (s)* in the object
d. Planning is the definition of the purpose of the change (s) one wishes to effect in the object
e. Planning is the *design of the actions* which will change the object in the manner that has been previously defined.

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(1) Allport, F.H., *Theories of Perception and the Concept of Structure,* John Wiley and Sons, New York: 1955.

These points can be tested by asking: "Would it not be planning to act in such a way as to ensure that the object does not change but remains exactly as it is? "

Obviously, merely not to act on an object would not be a manifestation of planning, except in the following two cases: (i) when the act of leaving the object alone *now* is motivated by the intention of acting on it at a later time; and (ii) when the act of leaving the object alone is motivated by the recognition that the object's ongoing state corresponds closely enough to what one thinks that state *ought* to be anyway.

Both these cases are variants of our hypothesis (d). The first exception is important inasmuch as it introduces the idea of deferral and "futurity" into our definitional scheme. The second is important because it implies a connection beween norms and pupose.

The various interrelationships that arise in planning with regard to the *on/for*, or *action/purpose* synergies, are graphically indicated in the following table:

ACTION "ON" PURPOSE "FOR"	NO ACTION	NON-DESIGNED ACTION (IMPULSIVE)	DESIGNED ACTION (RATIONAL)	DEFERRED ACTION (RATIONAL)
NO CHANGE	No Planning	No Planning	Planning occurs	Planning occurs
RANDOM (or NATURAL) CHANGE	No Planning	No Planning	1) Planning occurs, or 2) Lack of Control over obj.	No Planning
DESIGNED CHANGE	Planning occurs	No Planning	Planning occurs	Planning occurs
DEFERRED CHANGE	Planning occurs	No Planning	Planning occurs	Planning occurs

Now we must consider the question of whether in planning – that is, in acting on an object in preconceived ways for the purpose of effecting preconceived changes in it – it may not be possible to find at least some relatively invariant, even culturally conditioned, reasons in whose light the "on" and the "for" could be tied to each other.

4.

In this search the first point that comes to mind is that if one acts upon something – be it a thing, or a system as we have defined them earlier – with the purpose of changing it, one would rationally do so because one has been able to imagine a state of that object which is more *desirable* than its present state. This change, from the viewpoint of the conceiver of it (the planner), also corresponds to an *improvement.* And, with this idea, we come face to face with one of the fundamental issues we shall have to work out in some detail throughout the balance of this paper ; namely, the distinction between the particular, subjective, individualistic idea of the desirable, and of improvement in contradistinction with more general ideas of *betterment* and the achievement of social *progress.*

If we try to explore the idea of "improvement" we find that most of the writing done on this subject debates the nature of improvement, and argues the question whether or not improvement does, in fact, occur. Interesting as this issue may be, the primary import for planning is that, for many reasons, Western man, by and large, is a being who – wisely or foolishly – *believes* in improvement. The true significance of this is that he believes in abstract concepts such as the good and the bad, and in midway stations such as "better than..." He tends to accept as an article of faith that progression from any given state or situation will lead to one that is better, if the conditions for such progression have been defined and set. This propensity is undoubtedly one of the factors which originally encouraged, indeed, made possible, the powerful idea of an evolutionary reality.

Improvement itself can clearly apply to individual endeavor. However, when the notion becomes a shared belief as, despite ups and downs and lags and gaps, it has done in the Western mind, we cannot fail to see that improvement in a social sense does, in fact, represent a belief in *betterment,* and that *progress* is what we understand when betterment is given somewhat more universal dimensions and ethical connotations.

These conceptual distinctions are operationally useful in this discussion for without them it would be almost impossible to understand the great dichotomy which our culture has developed and nurtured regarding the relationship of the *individual* to (should one say, versus?) *society*.

One way to explore the nature of this dichotomy is to follow the development of the idea of "progress" through the history of our thought. In that history the idea of progress has had a somewhat erratic career. Its present form is probably a nineteenth century invention; long before, however, the notion operated within the moral consciousness of Western peoples. It did so in many and differing modes. The Socratic view emphasized an individualistic approach (actually reversing an earlier trend) and postulated that the individual's search for, and attainment of, *virtue* was dependent on self-knowledge and that inner growth toward the knowing of oneself, and thereby possibly coming to know the "good," was the only progress worthy of human concern.

While the Socratic and post-Socratic philosophers were not insensible to the fact that the greater the number of self-knowers the "better" for society, they tended – as in the case of Plato – to restrict the potential for self-knowing to an intellectual élite. As one of the results of this, the idea of *themis*, social order, which had been one of the glories of Greek achievement and thinking, declined gradually into an incidental item, into merely another pre-condition of the individual's search for virtue. In time, Diogenes and the Cynics dismissed it from serious discourse as a conceit bereft of meaning or value.

Christianity, with its basic concern for individual salvation and the sanctity of the single soul, further contributed to the growth of this individualistic emphasis. It did, however, introduce the notion of *love* into the general configuration of morality, but aside from this important step both individualism and élitism, with their connotations of exclusivity, continued to prevail.

Meanwhile, the notion of "material progress" had followed a somewhat contrapuntal evolution in relation to the foregoing events. The Socratic deflection of philosophic thought inward, toward the individual, had led Plato to dismiss concern with material pursuits, that is, with technology in general, as an insignificant feature of human experience; the result of this tendency being that he went so far as to exclude the craftsman – the man who shaped and made things for use – from the hierarchy of his Republic. On the face of it only one thing was saved from the general débacle. As J.-P. Vernant notes, "the reflections of the Sophists on human *technes*....found their way into rhetoric ; they established dialect and logic." (1)

Then, when Christianity exalted the Divine Kingdom above the material world – even to the extent of despising the material – a profoundly divisive and dualistic attitude began to pervade the Western outlook on reality. The moral and the material were weighed against each other as separate, and often adversary, entities. Material progress stood not alongside but in contradistinction to moral progress.

Since those times, however, things have changed, in the sense that a discontinuity in outlook seems to have occurred. Thus, our present notion of progress, at least in its most prevalent form, is a curious phenomenon. As was noted earlier, it is, on the surface, a product of the nineteenth century, when in Crane Brinton's words

> "...the idea of progress, vaguely conceived as a rapid improvement in general prosperity and happiness, became a living force. The chief reason for this was no doubt the rapid change in the outward conditions of life consequent upon the technological revolution." (2)

Yet, as we shall see later, the current view of progress is imbued with the complex and contradictory history of the entire idea.

The very important and central notion of "technology" as we, today, understand it, can be related to yet another branch in the evolution of the idea of progress. This line of evolution became visible at the time of the Reformation when Christianity had crystallized into several embattled dogmas, losing thereby some of its momentum and all-absorbing energy. It was during this hiatus that intellectual concern became redirected toward the natural environment and man's perception was reawakened by a new and illuminating principle: the idea of *truth* as that which derives from the correct observation of nature, and of the laws that govern its phenomena. From this principle our science was born; and from the marriage of science (in its applied mode) to economics, our technology – the reviver of the notion of progress – came into being. Crucial to its advent is that it came into being with a vengeance; and, before we realized what was happening technology and progress had become synonymous.

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(1) Vernant J.-P., ***Mythe et pensée chez les Grecs,*** Maspero, Paris, 1965. (The English wording of the quotation is by M.I.Finley.)

Re concepts discussed in this section also see: L. Edelstein, ***The Idea of Progress in Classical Antiquity,*** John Hopkins, 1968.
T. Cole ***Democritus and the Sources of Greek Anthropology,*** Western Reserve University Press, 1968.

(2) ***Encyclopedia of the Social Sciences,*** original edition.

Technology as one of the descendants of science operates in large measure by using scientific approaches and methods; in this sense it reflects some of the modalities of inquiry that are found in scientific endeavor. However, the *raison d'être,* hence the fundamental value premise of technology differs from that of science. The aim of technology is not *objective truth* in the form of knowledge for its own sake. It is the application of knowledge, by means of various transform methods, to material things so that the latter may be changed into novel states of being that people find useful. Nor is this usefulness solely embedded in a fixed and final outcome. It refers to many steps, to the creation of tools, machines, and processes – intermediate steps – from whose operations the end result (mainly, consumer goods) can be attained.

Thus technology is governed by the principle of *utility* which embodies the recognition that, from the continuous, goal-directed experimentation encouraged by science, one can derive certain warranted conclusions which, in turn, permit the construction of highly complex objects that are useful. This governing principle is also shared by the engineering arts and by economics. In engineering, utility is expressed by the consideration of "Will it work? " (something is not useful if it does not work); in terms of economics, utility is expressed, by considerations such as "Does it fulfil a need – i.e., is there a demand for it? " and "Can it be produced at a cost which will permit the demand to manifest itself? " Hence the value structure of technology has three basic components: scientific and engineering components, which largely govern its methods, and an economic component.

The synthesizing of these three elements has created such a powerful institutional momentum that it has made technology one of the most potent agents of change known to man; technology alters, multiplies, speeds up or slows down, or in other words, controls natural processes. Through such effects, it permits man to recast the order of things in ways that create new possibilities, new opportunities, new options for action, and an ever-varying pattern of choices. This is what one has in mind when one says that technology extends the feasible, that thanks to it man can do more things, and that it opens the way to new and numerous strategies through which one can channel action. A world view resting on technological premises and directed by a stream of technology-conditioned strategies and feasibilities exercices sufficent influence drastically to alter human behavior. Thus we find ourselves confronted with massive "social change."

The approach to planning discourse that we adopted in the preceding section now forces us to raise some very vital questions, namely: "Does this technology-fed social change amount to an improvement or betterment of the human situation? " Or, "Are the social changes which technology is continuously generating, in any way related to the notion of progress ? " Or, "Is technology a pre-condition for effective planning? " Or, "Is technology the result of man's planning propensities? " Or, "Is technology a powerful planning tool which man has finally brought into being? " The reader will have realized that these questions are related. Hence one might try to answer them in terms of some general and unifying framework.

We can find such a framework by observing technology's own dynamics, and even a cursory observation of this dynamics reveals that the phenomenon we call technology either suffers from deep contradictions in its essential make-up, or else it forces contradictory consequences both upon man's mind and his environment. I shall briefly illustrate what I mean, by taking varrious soundings from current reality.

The first characteristic of technology which should be noted is that it tends to feed upon itself and expand. It evolves in chain-reaction fashion within single applications and sometimes across different fields of application. Whether the moving force behind this phenomenon is its techno-scientific component or the economic one is not always clear; what is clear is that this behavior makes it both extremely difficult to predict the consequences of incipient developments on the socio-political system, and extremely challenging to conceive of methods for making predictions that can claim a high level of confidence. On the other hand the seemingly self-propelled dynamic of technological development and the vigor of its momentum tend to create a general feeling in us that the future is "given," and that, therefore, we must do our utmost to predict it. This relatively new and almost obsessive predictive trait in our thinking leads to the belief that the future is there to be discovered if only one could go behind the undefinable cloud which blocks our vision. In this way energies are channeled toward the invention of methods of prediction rather than toward the invention of the future. Such an allocation of energy, clearly, has grave implications for planning.

Another characteristic of technology is that it has all kinds of built-in "costs". Here, I use the notion of cost, not in its strictly monetary meaning but in the most general sense which pits it against the notion of commensurate "effectiveness." Thus, rapid, massive, cheap production is a gain we owe to technological advances, but pollution, which is a by product too, is a cost. Rapid transportation is a gain; noise and nature-destructive-highways are costs. Speed in getting there is a gain; the fatigue of the one who gets there is a cost. The prosperity of growing cities is a gain; the decreasing possibility of living in them while remaining human is a cost. Mining wealth from the soil is a gain; destroying nature while doing it is a cost. Fishing more fish is a gain: depleting the oceans is a cost, etc. Until recently these trade-offs were not quite as evident as they have now become. And now it is getting to be increasingly painful to have to pay these bills and to watch helplessly as we go on incurring the higher and higher costs. The end is not in sight. We are in the grip of a very powerful dynamic.

Yet another characteristic of modern technology is that although its costs are system-wide, the gains never seem to add up to system-wide improvement or betterment. This is implied in all the characteristics we have reviewed until now. Fast planes can be made to go faster, more and better highways can be built for more and better cars, good bombs can be improved, computer-aided instruction can help three-year olds learn symbolic logic, toasters can be made to roast turkeys – but is the system as a whole improving as a result of all this? The answer is not "We don't know." The answer is not "Maybe." The answer is "No." This imbalance of technology's effects throughout the system is perhaps its gravest shortcoming and most serious inner contradition. It appears both in time and in space in terms we have nowadays learned to call "lags" and "gaps". These simple words refer to extremely profound dislocations in the structure of society as well as in the relationships among social systems.

Wherever and whenever such an imbalance exists it can be taken either as a very advanced symptom of deterioration or the actual deterioration of the quality of life. Thus, if we look at the world in general, we find that in many large areas traditional agricultural value systems are in full disintegration, while the industrial value systems that are supposed to supplant them have not yet wholly come into being. In such a situation often the two unmatched value systems try to co-exist. It is at best a difficult attempt with grave tensions building between the old and the new, and with no real synthesis visible, or possible, in most cases. Again, from the international point of view, we have recently recognized the existence of that very complex and large-scale imbalance called the "technological gap". Although the expression is probably a misnomer, the phenomena it covers are due to the very different rates at which highly traditional value systems can absorb, adapt themselves and compete with ever-renewed forms of technological encroachment and the institutional as well as organizational alterations these necessitate.

Within the framework of national societies we find similar, more finely detailed gaps. In the United States today one could easily talk about the health gap, the education gap, the opportunity gap, the income gap, the color gap, etc., all of which might be said to add up to various imbalances among social sectors and the inability of some social sectors to keep up with the changes imposed upon the whole system by technology-induced rates of change. Clearly, there would be no overall problem if every sector was a system closed unto itself. Yet, the promises of technology constitute ends which may well be fantasies, but which nevertheless pervade the meta-system (1) and infuse it with uniform expectations.

Consequently, the gaps that confront us do seem to represent, when synthesized in human terms, what we now call the "expectations/achievement gap". Moreover, unfulfilled expectations, as well as technology advances, create novel patterns of behavior; the very frustrations which arise from the expectations/achievement gap lead to social restlessness as well as to other negative social attitudes. Thus, on the one hand, one ends up with riots, hooliganism, self-destructiveness, and the whole larger phenomenon of "copping out;" and on the other hand, one finds all sorts of existing social instrumentalities reacting against the manifestations of outward behavior rather than the prime causes of such behavior. For instance, we have the police and law enforcement agencies that feel the need to control disorder by the imposition of order at almost any price, while at other levels of occurrence, one encounters banks unwilling to make loans to the under-privileged, insurance companies unwilling to insure, shopkeepers unwilling to give credit or charging usurious rates of interest. In these complex ways the situation feeds upon itself, increasingly fragmenting the psycho-social space.

Aside from this, we also have the deterioration of our physical space, of our environment. The causes are similar. Just to name a few for the sake of descriptive symmetry, we have pollution, city and neighborhood decay, overcrowding, ugliness, and all the other environmental imbalances we have talked about so much and for so long. These blights feed back into the human behavior pattern. Their influence is a brutalizing one. And between the deteriorating physical space and the deteriorating psycho-social space all the loops are closed and as one feeds upon the other the problems grow.

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(1) Ozbekhan, Hasan, *The Role of Planning and Goals in the Solution of the World Food Problem,* Professional Paper SP–3118, System Development Corporation, Santa Monica, California, 1968.

Problems of this kind are the outward manifestation of extraordinarily complex issues that have become deeply embedded in our situation – relations between the races, the stubborn persistence of poverty amid growing affluence, urban dissonances due both to continuing mismanagement of city-growth and to the basic unmanageability of this growth, the constantly renewed inadequacies of our education, the growing lack of privacy, the inability of our institutions either to cope with the rate of change or to stop it. These social morasses in which we have become stuck again make us question whether our institutions, our accustomed ways of doing things and solving problems are becoming insufficient. The answer comes almost inevitably. They are.

This fact as well as the manifestations of earlier characteristics of technology are perhaps best seen in what is happening to our "policy" outlook. As a result of the second World War, during which highly concentrated scientific effort was directed to overcoming technological problems, there has emerged in the United States a new type of policy component. And because it is only a component it would not be correct to call the result "technological policy". What it happens to be is a perceptible increase in our reliance on technological solutions for problems that are observably non-technological. This reliance on technology now enters into almost all our policy making, and has transformed technology into something like a generalized principle governing all other policies.

Moreover, this relatively new development has occurred at a time when we are confronting a plenitude of problems whose fundamental character is *social*. And these problems have begun to display such virulence that they are causing a great many people to question the very quality of our way of life. What is profoundly noteworthy in all this is that our attempt to solve social problems by means of technological policies obviously implies certain deep assumptions that we make almost without thinking.

The most fundamental assumption in this instance is, clearly, that the governing values of techno-scientific endeavor – objective truth derived from correct observation of phenomena from which, in technological terms, it is possible to attain material results that are useful – are equally valid in the solution of social problems (1). This is, undoubtedly, a very major, a crucial assumption which one could say defines and regulates the meaning of life in most Western countries today. But is this assumption warranted? One might

(1) For a good statement of this viewpoint, see: Weinberg A.M., "Social Problems and National Socio-Technical Institutes" in *Applied Science and Technological Progress*, (The National Academy of Sciences, U.S. Government Printing Office, 1967).

argue that it is insofar as our social problems have large technological components. Surely this is begging the question. The point remains that until now the assumption has remained unproved. One might even go so far as to say that it has never been widely questioned. Hence, all we are able to venture when such a question does cross our minds is that we have as yet failed to invent an alternative hypothesis to the one which postulates that, since the techno-scientific approach is effective in one realm of human endeavor it must, therefore, be effective in all.

The consequences in policies and action that result from this hypothesis are vast. For instance, we have come to think almost exclusively in technological terms and to use technological concepts – by replication or by analogy – regardless of the nature of the problem being addressed. This indicates that we now perceive reality – configurations of objects, problems, and solutions – mainly in the guise of devices and mechanistic procedures. Technology, therefore, is the central component, perhaps the major and dominant component, of our present world view.

5.

It is time to stop for a moment and try to organize the various ideas we have been dealing with into some kind of meaningful arrangement.

To summarize: we started with the notion that planning is to act on an object for the purpose of changing the object into some state that is more desirable than its present state; then we noted that from the planner's viewpoint the conception of more "desirable" could be equated with the conception of "improvement." Perhaps arbitrarily, we related the ideas of desirable and improvement to an individualistic outlook so as to set them up in contradistinction to the notions of "betterment" and "progress," which we stipulated as being social in character. From a brief review of the idea of progress we further determined that a well-established dichotomy existed between "individual" and "social" and that this dichotomy had, from early on, become an almost permanent feature of Western thought. We found that since the Industrial Revolution, "technology" had grown into the main vehicle as well as the driving force and the dominant agent of what we now understand by progress and that as a result of this identification, we were increasingly tending to try to cure the large-scale dissonances encountered in our social dynamics almost exclusively by means of technological methods and solutions.

It goes without saying that there are profoundly important conclusions to be drawn from such observations. These conclusions should provide the ground for the discourse from whence we must proceed, first to define the philosophical and conceptual *content* with which we think planning must be suffused and, secondly, to invent the methodological structures and substantive constructs that are required to lay down the foundations of a planning theory which, in time, might become a powerful instrument of social betterment.

The first question that needs to be raised to allow us to take the initial step is: "Why have techno-scientific approaches, which are so successful in bending nature to human will and in controlling it, proved less than adequate in achieving social progress?" Clearly, there are many lines of reasoning that might lead to valid answers. However, the context within which we have to conduct the argument suggests the reply that our traditional conception of technological applications has inordinately favored the approach we know as *methodological individualism.* This approach (for reasons that will be explored in Part II) is deeply rooted in the history of the Western value system. What it convincingly proclaims is that it is impossible to establish a connection between social ends and individual preferences and that every individual must therefore act in the light of his best self-interest. Insofar as society is concerned there is always the implicit hope that independently maximized values resulting from such action will ultimately add up to progress. This assumption to which we shall return repeatedly, rests on a profound – and perhaps tragic – misunderstanding of the nature of what we have called complex dynamic systems. Be that as it may, I believe it is by now self-evident that the increasing social and psychological disquietude, which marks and mars our age, can be traced to the many-levelled fragmentation fostered by methodological individualism.

This reasoning, especially when advanced side by side with a description of the improvements technology has fathered, would seem to encourage the conclusion that it is not technology but our social conceptions (methodological individualism being one of them) that are at fault. Such a conclusion would be incomplete and, therefore, incorrect.

True, technology has caused almost numberless improvements in our ability to cope with the environment. Nobody can dispute the fact that our mobility and the opportunities that accompany it have grown exponentially. We also know that our agriculture supports vast populations with very little investment of effort, and that the natural resources of the world are being brought into more efficient use for the greater benefit of a majority of (Western) peoples. There is no denying the majestic momentum which has changed human toil into human work and promises to change human work into leisure and thereby permit the realization of the human being's full potential. Pages and pages of examples could be added to the list. However, in the context of the central issue we are discussing, these examples represent sectoral improvements, and sectoral improvements are irrelevant because no matter how they are computed they do not add up to the progress of the whole society.

"Why not?" Here, a most significant point comes to mind, one that is intrinsic to the nature of technology rather than to any methodological shortcoming, namely, utility does not inhere to technology *per se,* but to machines, processes and finally to products. All these are unitary objects, physically bound by their nature to what they are. Hence their utility cannot be generalized even when the objects themselves are replicated *ad infinitum;* nor do the laws of divisibility allow that they be reduced into parts providing the same utility. Any progress such objects can generate evolves in parallel lines without being able to cover the whole system, for the system itself changes under all their fragmentary impacts. This kind of progress must therefore rely on single outcomes and on limited, undependable, and difficult-to-foresee synergies.

Once this point is established, the other reasons why sectoral improvements do not add up to the progress of the whole society become easy to uncover. Let me list them briefly: (a) sectoral improvements are inevitably beset with conflicting purposes; (b) what we have called the "whole society" is, in fact, a "whole system"... the very habit of looking at society in terms of sectors is already an arbitrary fragmentation and, unless we can devise means whereby we are able to conceive of, and deal with, whole systems in terms of planning, we shall never solve this problem – either conceptually or in fact, (c) the primacy we give to the problem-solving virtues of technology reinforces the fragmenting tendencies that inhere to our vision, our purposes, our institutional structure, and to our modes of decision making.

C.W. Churchman has stated the core-problem as follows:

> "We are all well aware of the fundamental debate going on in the world at present concerning the question of social values. On the one hand in the West there is a strong emphasis on the value of freedom of the individual to make his own choices, for example, the choice of the people who will govern, the choice of his career, the choice of his wife, the choice of his own way of living. In the Eastern sector of the world, however, there is a strong objection to the negative value of exploitation, that is, the negative value of the economic advantage certain individuals have over other individuals.
>
> The positive value of freedom has long been recognized in historical writings. Men have extolled the idea of individual freedom ever since the

> earliest days of Greek philosophy. But men have also pointed out the need for a well organized society based on rational, nonexploitative principles, also since the days of Greek philosophy.

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> The value of individualism seems opposed to the value of social planning...
>
> Opposed to the value of individualism is the value of "rationality" in social planning..."(1).

And, one of the (interim) conclusions that Churchman reaches as a result of these considerations is that: "The ethics of the large-scale system is usually at variance with the ethics of a sector." (1).

In sum, we are confronted with a value-dissonance, and if planning is to succeed we must first resolve that dissonance. By now it seems pretty safe to conclude that continuing to advance along techno-scientific lines is not going to lead us to any solutions in this respect. If anything, it will make matters worse. To resolve the value-dissonance we must not only create an *ethic* that has operational meaning in terms of large-systems, we must also question the attitudes and mental habits that our technological world view has imposed on our minds. And this we must do, not in political terms (as Churchman basically tends to do in the above passage) but in terms of our tone of thinking... we must put to question the very concepts that govern our vision and help us form our mental constructs. What I am suggesting is obviously very difficult because it calls for a reconsideration of the rules of legitimacy in value generation. This difficulty is increased or, I should perhaps say, exacerbated by the fact that all of us -- including this writer -- have minds conditioned by techno-scientific outlooks, which makes it a formidable effort to conceive of other, alternative, ways of being right.

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(1) Churchman C. W., *Challenge to Reason,* McGraw-Hill, New-York, 1968.

II.EPISTEMOLOGICAL CLARIFICATIONS

1.

One of the fundamental reasons for this is to be found in the nature of what Galbraith has called the "conventional wisdom of our times".

For my purposes here the quickest way to describe what this wisdom proclaims is to say that, among other things, it makes a powerful distinction between what it chooses to call *hard* and what it chooses to call *soft*. Whatever is hard is admired, whereas the soft arouses emotions that are less forthright although they do tend to be on the negative side.

From this distinction has arisen a whole techno-scientific mythology whose classifications are crystal clear for the true believer. Thus, "objective" defines the hard, "subjective" defines the soft; "is" is hard, "ought" soft; "science," if by that you mean hard(i.e.,physical) sciences, is very hard indeed, while "ethics," no matter what you mean by it, is soft; "analysis" is clean hard-contoured, but "policy" is fuzzy at the edges; "description" when it reflects observation conducted according to the rules of empiricism is possessed of hard-as-nails qualities, "prescription" is hard only because it is hard to bear, "means" are firm when available; "ends" – alas! – are mostly softened by being too remote. Finally, there are "facts." Facts are very hard. Facts are what make the *is* hard; and sometimes it is the *is* that hardens facts, it depends with whom you talk. Not so with "values." Values are always soft. Values underlie *ought* statements, they turn mysteriously into prescriptions; and, before you know, they plunge you once again into ethics, into things like duty, love, the good, etc., which would be all right except that they force you to make judgments, value judgments, and forever to decide what is good and what is bad, knowing all the while that there is no hard measurement for that kind of thing. And so on.

So much for the techno-scientific mythology of our age. (One is tempted to write *mythodology)*. Put the way I have, it sounds funny. Yet it is serious for it exerts an immense influence on all our thoughts and all our decisions and actions, whether or not we believe in it. It has set the intellectual style of our time; knowingly or unknowingly we permit it to guide, shape, direct our outloock, our attitudes, our manner of perceiving reality, our way of establishing priorities. And it is strongly founded, as we shall presently see, for it is the outcome of a long effort. Centuries long.

To be completely fair, I must add that in recent years these curious habits of mind have slowly begun to change. But they are changing too slowly. And as long as this pace is maintained we shall not succeed in escaping yesterday's fires, to address ourselves to today's decisions – which is the same as saying, to the real dimensions of tomorrow. To make this escape, we must learn one very important thing: that the future consequences of human action inhere to the decisions we make and should therefore be viewed as today's facts. To ignore this is to build on ground that is growing shaky both scientifically and philosophically. It is to suffer from what amounts to a failure of ethical sensitivity as well as to a failure of wisdom. This is mainly because seeing the future as mere fantasy precludes it from being a subject for serious inquiry. It stops us from acting responsibly toward it, hence toward the present it contains.

Yet those intellectual habits, which currently nurture and sustain our world view, cannot be dismissed lightly. We have to assess their worth and determine what is right about them, and what is wrong. If we fail, then planning as well as any planning-related research, namely any research, focused upon the future, must be denied status as a dignified and practical pursuit and be relegated to those soft regions where hard minds are loath to venture.

Therefore, we must now look at planning within the context of current scientific thought – that is, in terms of those rules of rationality that are generally accepted as constraints to be imposed upon discourse in order to validate such discourse. From this discussion, planning will emerge either as a legitimate body of thought, or our current rules of rationality will reveal some shortcomings. In either case we should have learned something we did not yet know about planning.

The reason why I have dwelt on this point is that it is central to any discussion of the epistemology of planning. For planning, as I see it, presents us with a rather complicated set of problems, depending on how one decides to define its scope and boundaries. If one views planning as an entire and complete discipline – as I, for reasons that will become increasingly clear in this paper, advocate – then obviously it suffers from all kinds and degrees of disturbing softness. It is essentially a normative pursuit. It deals with "futures" (in the latin sense of *futura)* rather than with "facts." To think in terms of such *futura* what *is* must either be elongated in time (thus being what we call extrapolation; a most unsatisfactory exercise), or be subordinated to *oughts* ; policy must dictate to analysis, prescription must supervene over description, ends must govern; preferences must be deeply probed and selected in relation to other, alternative preferences ; they must be ordered in terms of values, and judgments must be made so that we can choose the norms that will warrant our decisions, direct them and give them weight. And, still worse, planning is thinking about what is not; about what may never be; it is imaginings and speculation. It is, on all these and many more scores, divorced from reality which, as all hard-headed "practical" people know and go around saying, is made up of facts – present facts.

How can these attributes be reconciled with the elementary demands of systematic thought and simple rationality? One way, I suppose, is to revert back to orthodoxy and to dismantle planning of its normative, futures-creative, open-ended and dynamic properties. Thus reduced in size and meaning plans become tools for the ordering, scheduling and control of confused day-to-day events. This is what generally goes under the name of "Short-Range Operations Planning." Such manner of planning, mostly administrative and tactical in character, is something we have grown quite proficient in, mainly because it is made up of hard routines and relatively simple quantitative techniques. Being basically a procedure, however, operations planning cannot generate the policies that are needed to give it guidance and direction. Therefore, it is dependent on, and subordinate to, other policy-making functions and activities.

This separation of policy from planning not only creates all sorts of additional interfaces between tasks, thereby increasing operational inefficiencies in ways that are all too familiar, but also provides us with some of the ludicrous consequences that ensue from the dichotomies erected within our minds. For if we accept a functional distinction between soft policy making and hard operations planning, we must also accept the rather disquieting idea that everything of truly fundamental importance, such as the choice of direction and of ends, falls somewhat short of being a wholly rational pursuit, whereas the determination and allocation of means or the working out of optimal schedules enjoys full rationality. Continuing in this vein, we find ourselves forced to start from the extraordinary premise that in vital undertakings, such as the selection, definition and, in some non-trivial way, the creation of our future, the less than rational governs the decisions, while the rational inspires the operations.

This outcome is strange enough; it becomes even more bizarre when we remember that is rests on the twin rocks upon which logical positivism is founded; I am referring to the *verifiability theory of meaning,* and the *emotive theory of value.* In this paper I shall not dwell longer than I absolutely must on the details of these powerful constructs. I must discuss, however, their significance (which is in the nature of major obstacles) for any attempt at building a theory of planning.

If, for our purposes in this paper, we forego all refinement and stick to the shortest of shortcuts, without disturbing the truth, we can say that the verifiability theory of meaning derives from the assertion that knowledge is made up of two types of propositions: "...analytic when (the proposition's) validity depends solely on the definition of the symbols it contains, and synthetic when its validity is determined by the facts of experience" (1). What this says is that *analytic* propositions are definitional and tautological in nature; while the meaning of *synthetic* propositions can be verified as being "true" or "false" with reference to empirical evidence. In still other words, synthetic propositions are "empirical hypotheses".

When such stringent constraints are accepted it becomes obvious that *normative* statements – namely, statements that contain or imply the operator "ought" – cannot be viewed as being real propositions of any kind, that is, as belonging to a legitimate class of meaningful statements. This dire circumstance arises because normative propositions are clearly bereft of any "cognitive" virtues. And, because of this grievous lack, they are exiled from the well-ordered realm of positive knowledge to a neighboring place – the land of values – where they pursue a rather precarious existence. Values present us with a panorama that is formidably obscure and confused. In fact we should know very little about them – that is, from the viewpoint of logical positivism – had it not been for the efforts of Alfred Jules Ayer, who not only gave us the most relentlessly consistent statement of the verifiability theory of meaning but also went to the trouble of exploring the moonscape of values, mainly because, like nature, he detests a void. These explorations have resulted in what I have referred to earlier as the "emotive theory of value" – the second rock on which the modern positivistic world view is grounded.

Briefly stated, this theory asserts that values are not expressed in the form of propositions but in the form of "judgments" – value or ethical judgments. Such judgments, furthermore, are said to be emotive inasmuch as they are statements about individual feelings, institutions, attitudes, preferences, commitments, etc., all of which can be subsumed under the general idea of emotion.

> "....in every case in which one would commonly be said to be making an ethical judgment, the function of the relevant ethical word is purely "emotive! ". It is used to express feeling about certain objects, but not to make any assertion about them" (2).

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(1) A. J. Ayer, *Language, Truth and Logic*. New York: Dover Publications Inc., 1952.

(2) Ayer, *Op. Cit.*

Such feelings, or judgments, cannot be validated in relation to any empirical fact

> "...not because they have an 'absolute' validity which is mysteriously independent of ordinary sense-experience, but because they have no objective validity whatsoever." (1)

So much for the emotive nature of value propositions. The next point of interest to us is the congruence they have with ethics. The congruence occurs in the manner in which "descriptive ethical symbols" slide into prescriptions :

> "It is worth mentioning that ethical terms do not serve only to express feeling. They are calculated also to arouse feeling, and so to stimulate action. Indeed some of them are used in such a way as to give the sentences in which they occur the effect of commands. Thus, the sentence 'It is your duty to tell the truth' may be regarded both as the expression of a certain sort of ethical feeling about truthfulness and as the expression of the command 'Tell the truth'" (1).

Thus, value judgments (namely, normative statements) embodying or implying "ought" contain an implicit imperative and that in some profound sense for someone to say "You ought to do x" is the same as saying "Do x".

Clearly, all the foregoing is intended, by means of a a highly consistent logical analysis and framework, to cleanse the scientific, namely the truly rational mind, from all metaphysical bias which might have survived in it despite all the scrubbing that has been going on in the past two hundred years. The deeper meaning as well as the true implications of this ethical neutrality can be found in two statements that were made almost one century apart. They both deal with the seemingly mystical relation that becomes established between man, the scientist-expert, and his field of knowledge. First I quote from a letter written by T. H. Huxley to Charles Kingsley:

> "Science seems to me to teach, in the highest and strongest manner, the great truth which is embodied in the Christian concept of the entire surrender to the will of God. Sit down before fact like a little child, and be prepared to give up every preconceived notion, follow humbly

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(1) Ayer, *Op. Cit.*

> wherever and to whatever abysses Nature leads or you shall learn nothing. I have only begun to learn content and peace of mind since I have resolved at all risks to do this." (1)

My next excerpt comes from Paul A. Samuelson, who, in the 1967 edition of his *Economics* writes:

> "Basic questions concerning right and wrong goals to be pursued cannot be settled by science as such. They belong in the realm of ethics and 'value judgments'. The citizenry must ultimately decide such issues. What the expert can do is to point out the feasible alternatives and the true costs that may be involved in the different decisions" (2)

Except for the imagery and the rhythm of thought that the language reflects, these two passages proclaim the same single and invariant positivist belief that the scientist-expert, the man who wants to know and who must know, has to approach facts in total *innocence*. He must come to them with a mind that has been emptied of values by an immense act of will, a painful wrenching. For only to the innocent will facts speak, and only be able to repeat the truth without distorting it. The one thing that is fatal to the state of complete innocence is the knowledge of good and evil. If he is free from such knowledge, the man of science can and will follow Nature wherever Nature leads, or know the true costs of different decisions. And (here the argument weakens somewhat) the "citizenry" will also know what fate to choose for itself if the scientist-expert is allowed to report the truth.

This fundamentalist view of man handed down, it would seem, directly from the Old Testament, is both powerful and beautiful. The point it unfortunately fails to take into account is the unitary nature of the human being and the vast patterns of complexity that make up the human condition. Is it possible to empty one's mind of feelings and yet remain human? Or of pre-suppositions? Is it possible to have one single thought without weighing it in terms of one's conception of the good and, in one way or another, taking a position? Is it conceivable, after having computed the consequences of various actions, to communicate these extraordinarily complex results to minds that are less well trained, less able to understand and to judge and to ask them to make the decisions, to take the responsibilities, for action ? Can one, after having done this, feel that one's duty as a scientist-expert has been discharged? Can one admit to the existence of such deep cleavages within the mind, the emotions, the soul, and remain rational?

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(1) Laura Archera Huxley, *A Personal View of Aldous Huxley*. New York: Farrar, Straus & Giroux, 1968.

(2) Paul A. Samuelson, *Economics*, 7th edition. New York: McGraw Hill, 1967.

These questions occur and must be answered. There is an inescapable necessity in this requirement. This necessity arises with special emphasis in the case of planning, because plans (as we shall elaborate later on) are in fact policies. As such, they act upon the destinies of individuals and societies alike. Hence, it follows that we cannot adhere to the dichotomous dicta of our socio–technological arrangements which legislate that planners (i.e., scientists and experts) will make plans and politicians will make policies; that planners will be rational, whereas politicians will follow the generally ill-informed desires of the citizenry ; that it is the duty of mature highly trained minds forever to construct rational plans for policies which they often recognize as irrational, ineffective and fraught with danger.

In the light of such facts it does appear unreasonable, if not impossible, to build an operationally meaningful theory of planning on the premises that lend logical consistency to our present world view.

This is not to say, but quite the contrary, that such a theory with its underpinning of values will ignore facts in favor of imaginings, or the grave constraints of feasibility in favor of daydreams. No. The rules of theory-building remain stringent; the facts to be accommodated can and must be approached with a cool head; they can and must be calculated and weighed; they can and must be compared, adjusted, altered, improved and maximized; they can and must be manipulated, fiffed together, analyzed, patterned and combined. But no matter what is done with them, they can never again be seen as standing free of the consequences which follow from them once they begin to generate decisions and action. Nor can planners (as expert professionals) be freed from the responsibility of recognizing such consequences, and acting upon them in the light of a generally shared ethic.

If a highly divergent approach were adopted, the entire normative content of planning would continue to be ignored; which means planning's *social* nature would continue to be ignored. It would remain an individual exercise as though it had solely individual consequences. Its main value-premise would not be rationality but a kind of private reasoning that often results in arbitrariness. No, the planner cannot be innocent: he must be acquainted with both the good and the bad, and he must have norms that permit him to define "good" and "bad" in such a way that he can make operational choices and ascribe ethical values to the options he invents, while simultaneously remaining rational.

2.

In order to see how the foregoing requirements can be satisfied we must now try to grapple with the value problem which, obviously, is extremely complicated. My intention is, again, to approach this subject by means of a critique of the position that has the widest currency at this time. I continue to prefer this manner of procceeding because it allows me to introduce the ideas I feel need to be introduced while keeping in view that which must be undone, or at least seriously questioned, in the intellectual configuration of the present.

Today we suffer from extremely confused and ambivalent attitudes toward the role that the concept of "value" should play in rational discourse. The reasons for this are many and, for the most part, they fall outside the scope of this paper. Nevertheless, at least the principal roots of the present situation need to be traced, for otherwise it would be very hard indeed to weave values, as operational concepts, into the argument that I am attempting to develop.

The shortcomings of rational discourse today – that part of rational discourse which is concerned with man and society – consist mostly in our inability to introduce value elements into the structure of thought. The reasons for this failure are, I believe, historically traceable. Thus it seems possible to argue, once again, that the initial cause of dissonance in this matter can be found, first, in the *absolute* concept of value we inherited through the Neo-Platonists and the Neo-Kantians. This is related to the inward, the self-ward, direction that was given to philosophic endeavor, mainly in the Socratic period. These trends reached us through many interim elaborations, one of the most powerful among them being the "atomistic" epistemology of British empiricism which became the dominant intellectual instrument of industrial, that is techno-scientific, civilization. The central postulate of this line of thought is that the meaning of value is wholly confined to the individual's judgment, for that judgment becomes triggered by an experience. Moreover, the range of such judgments is held within amazingly simple confines. Thus, value is ascribed to something in terms of the pleasure one derives from it – which, in negative progression becomes a pain. And, similarly, value is measured in terms of the utility one derives from something – which, in negative progression becomes dis-utility. The scheme is extremely simple, parsimonious and elegant. It has one drawback, however, in that because both pleasure and utility are defined as an individual's sensations, it is impossible to make comparisons between or among them. Hence no fundamental social considerations can be introduced into any calculus resting on this postulate for, according to it, the world is made up of people in the singular, sensing and experiencing alone.

To repeat: All sensation of pleasure or pain as well as all decisions about the utility of anything are value judgments limited to an individual's incommunicable experience and feelings. The objects of value may be public, but the experience and judgment of value are hermetically private.

The modern statement of this argument, as derived from Bertand Russell, is extremely interesting for it shows how cleanly the twin theories of verification and value can be brought together and synthesized:

> "Though physical objects might be publicly accessible, sense data were to be taken as private. There could be no question of our literally sharing one another's sense data any more than we can literally share one another's thoughts or images or feelings. The result was that the truth of such elementary statement could be directly checked only by the person to whose experience it referred."(1)

To my knowledge, it is only recently that we have grown seriously dissatisfied with both the premises and the conclusions of methodological individualism as superbly represented in the above quotation. This dissatisfaction has resulted in an increasingly critical re-evaluation of all classical epistemology.

The main thrust of this criticism is directed against two weak points of the earlier position. These are:(a) that verification is an incommunicable private process; and (b) that what positivists define as "value judgments" are in fact value judgments.

Insofar as the question pertaining to the privacy of experiential verification is concerned, I share Bronowski's view that such verification is fundamentally a social process rather than a feeling forever sealed within a person, for the reason that "truth" is a social fact. The central argument here is that "there is a social nexus which alone makes verification possible....it follows that there is a principle that binds society together because without it the individual would be helpless to tell the true from the false. The principle is truthfulness." And the recognition of this relatively obvious fact becomes fully orchestrated in the statement, "We OUGHT to act in such a way that what IS true can be verified to be so"(2).

(1) This succint statement of Bertrand Russell's theory of verification is taken from Logical Positivism, A.J.Ayer, Ed. New York : The Free Press, 1959.

(2) J.Bronowski, *Science and Human Values*, revised edition. New York: Harper Torch Books, 1965. (N.B. "Ought" and "is" are capitalized in the original text.)

I shall return to the importance of viewing verification as a social process in a moment. Before I do that, I want to pass on to the second line of criticism which puts to question the positivist definition of "value judgments."

Because we have always been told that statements like "I prefer x to y," were value judgments, we seem to have actually come to believe that they are. The question is: "Are they?" The time has come to reassess this passive acceptance which is almost akin to intellectual sloth. And the first step in this reconsideration is to ask : Why should all value (or ethical) statements necessarily be judgments ? Why can they not be mere *valuations?* Let us now explore the difference between a value judgment and a valuation.

It is my opinion that this line of questioning has led the modern cognitivists to some extremely rich and interesting conclusions. It has permitted them, among many other things, to establish a set of basic distinctions which – in the light of positivism's inability to grant any logical necessity for defining all valuation statements as judgments – creates a much stronger and more consistent framework of concepts. This framework provides us with the following distinctions between "valuation," "value judgment," and "norm" which, operationally, are of great importance: (a) *valuation* is a statement wherein an appraisal is made; in this type of statement a norm is assumed to exist either explicitly or implicitly, but they are not created by the statement, (b) *value judgment* is that type of judgment which has as its purpose the definition of norms that pertain to some types of valuation;(c) *norm* is the value standard or rule in accordance with which valuations are made.

These distinctions permit a number of conclusions which have operational significance, especially for planning: (i) private emotions cannot, in themselves, legitimize valuations; (ii) what legitimizes valuations is the process by which the norm for any valuation is determined; (iii) this process is social in character; (iv) this permits the pre-supposition that value propositions have empirical meaning, namely, that they can be justified by evidence which is socially held to be true.

It is the recognition of this truth which lends such power to Henry Margenau's statement: "Values in isolation are like facts in isolation, they are meaningless" (1).

There is now one extremely important point that we must still deal with. It is important because it introduces the concept of "ends" (a concept that is central to a theory of planning) into the discussion.

(1) Henry Margenau, *Open Vistas*. New Haven: Yale University Press, 1961.

It has long been a major contention of positivism that statements containing the operator "ought" are not directly testable as to whether they are true or false. We have already encountered this assertion under many guises. In the form I have just stated it the contention is doubtless correct. What is faulty are the two conclusions that are usually derived from it. The first conclusion is the classical one: our inability to test ought-statements directly invalidates them as conveyors of rational thought (because they are expressions of irrational emotions, etc). In earlier pages we have, I believe, argued sufficiently convincingly against the substance of the rational/irrational dichotomy, and need not go once more over the same ground. What we must now do is to dispute the mere logic of it. This can be done by arguing that it is not only ought-statements whose truth or falsity is impossible to test directly, for every single statement we make, regardless of its kind or class, suffers from exactly the same shortcoming. In other words, the operator "is" cannot be tested directly, either – unless we rely entirely on objective appearance in contradistinction to objective truth; a reliance which, of course, would immediately defeat the very purpose of rational discourse as well as of positivism. Hence, let us begin by saying that insofar as *logical identity* is concerned both *ought*-statements and *is*-statements need a great deal of analysis because to determine the truth or falsity of either we must penetrate and explore the meaning of the "ought" and the "is" through every step of the process of valuation and do this with constant reference to the particular dimensions of the reality – context and parameters – of which the statements that contain them are a part.

There remains, however, the second conclusion; one we must now consider in some depth. This asserts that if we engage in the process of valuation and reality exploration, as just described, what we are actually doing is searching for a standard or norm that will allow us to make a judgment ("true" or "false"). Such a search will clearly have to take the from of an infinite process of regression until we reach some *absolute* or *ultimate*"end" – for, up to this immovable floor of incontrovertible certainty, it will not be possible to encounter an end that is not also a means to some other end. Thus the process will lead us right back into metaphysics and to the postulation of the existence of a "first cause", which represents an absolute "good". Obviously, at this point all rationality must drown in the quicksands of subjective considerations (1).

This argument looks powerful indeed. And despite its quite medieval, almost scholastic, flavor it requires a serious answer. There is no doubt that the structure of Western thought or moral experience can no longer accommodate the notion of an ultimate or absolute good. We know that the values we ascribe to ends and means change over time so that it is possible to perceive history as a concatenation of goals, some of which have greater universality and are more distant in time than others which are intermediate both temporally and in their application. Generally speaking, the most nearly universal and longer term goals are those that are viewed as ends which embody the good, while intermediate goals are means which stand in some relationship of consonance to that good. Thus, ends, which may be universally recognized as good but no longer as ultimate, can be defined, relative to a given system, both in temporal and in spatial terms. They have historicity. And every time one level of attainment is reached it becomes imperative to redefine the next level with reference to the new reality created (1). The real question is, therefore: is it incontrovertibly necessary for such redefinitions to go back to the notion of an absolute norm, *(summa bonum)* that stands as an ultimate end at the thresnhold of all manifestations of reality? I think this question is best answered today by the straight-forward and straight-faced comment that in the long chain of end and means there is no particular link which by its immanent nature is a starting point, yet every argument or idea does originate from one such link or another. Which one? That depends, I feel, more on the nature of the idea being developed than on the *locus* of its origin. And, as to the *locus* itself, it is nothing more than a convention established by the very values we have been discussing, values that govern the world view of a particular culture at a particular time (2).

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(1) This and the following points have been powerfully argued by A. Kaplan, *The Conduct of Inquiry*. San Francisco: Chandler, 1964.

3.

Perhaps it might be useful to conclude these epistemological considerations by restating the concepts which are to be used in the outline of the planning theory starting in the next section. What is important at this juncture is to be definitionally or descriptively clear, so that inconsistencies can be avoided later on.

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(1) See H. Ozbekhan, "Technology and Man's Future," System Development Corporation. Professional Paper, SP—2494, 1966.

(2) A recent paper by P. D. Bush, "The Normative Implications of Positive Analysis," which was presented at the Western Economic Association Meetings. Corvallis. Oregon, August 23, 1968, makes many of the points found in this Part with respect to economic analysis. I regret that Dr. Bush's paper came to my attention too late for me to quote from him extensively. Besides being cogently argued, the paper also contains a good list of references. I am obligated to Dr. N. M. Kamrany, Senior Economist, Planning Directorate, System Development Corporation, Santa Monica, for communicating this paper to me.

I think it is evident by now that I do not reject such concepts as ends, means, values, valuations, value judgments and norms from planning discourse. On the contrary, I welcome them because I believe that they will enrich the discourse and enlarge understanding of the planning process as well as the operational usefulness of plans. Hence in the following paragraphs I shall restate and elaborate them briefly, indicating the sense in which I shall employ them from now on.

By *ends* I shall mean outcomes that are general, distant, and in some ways ideal; that is, outcomes which, within a particular culture are viewed as embodying "the good."

For our purposes, the main attributes of ends can be defined as follows:(a) They are universal, in the sense that the good which is said to inhere to them must represent a widely shared belief prevailing throughout the entire space of a given culture. They identify, in other words, the central tendency that gives momentum and direction to the culture as a whole. (b) Temporally, ends are relative, namely capable of changing and of being changed. (c) The concept of ends will be seen as having ethical content despite being circumscribed by duration, specific cultural space and change; and despite the fact that the authority of the concept is socially determined.

I shall use *means* in a general way to refer to objects, acts, decisions, processes and procedures – everything that permits the attainment of ends. I shall also use means to refer to an overall situation which, at one time, might have been viewed as an end but which, as it becomes fulfilled or satisfied, allows the envisioning of other further ends whose content and general configuration is, and could not have been, but derived from such interim steps.

By *values,* I shall mean the dominant, historically evolved commitments of a culture or society. Values define the way of life as well as the quality of life – or rather, the style of life – in such cultures or societies. For example, the notion of "good" which inheres to ends is the highest overriding value that is at the apex of a whole supporting hierarchy of values leading down from commitments to preferences. The notion of values derives its operational importance from the fact of embodying the fundamental criteria of choice. And who says choice, says action – that is, behavior. Hence values govern behavior, and a change in values results in a change of behavior. Here a distinction – an important distinction – needs to be noted. There are *individual values* and there are *social values.* Individual values are commonly said to become manifest in the form of preferences. Social values, on the other hand, are seen as referring to larger scale, perhaps more stable and more formal commitments of a whole culture, from which individual values can be abstracted.

I shall term *valuation* (or value statements) those expressions which, during the decision process, serve to elucidate value alternatives without, at the same time, revealing a clear norm that might necessarily impose a necessary commitment to act in a particular way. A spectrum of desirable outcomes, in other words, would be composed of a series of valuations.

By *value judgments,* I shall refer to those statements, in a decision process, whose purpose is to define, select and test norms as applicable or inapplicable, valid or invalid, legitimate or non-legitimate, with reference to specific valuations or alternative lines of action.

By *norms,* I shall understand the rules or value standards which permit us, in relation to specific values (or general ends), to determine the legitimate value content of alternative valuations. For example, if "justice" is accepted as one of the manifestations of the good as an end, and "laws" are viewed as warranted by values that satisfy the necessary attributes of justice, then "legality" can be said to represente the norm to be applied in decision making.

Thus in the active mode one could perhaps say that: one tends towards ends; one uses means; one asserts values; one makes valuations and value judgments; and, one applies norms.

With these points in mind, we shall now proceed to outline the main elements that seem to be required in a theory of planning.

III. OUTLINE OF AN INTEGRATING CONSTRUCT

1.

At this point, having established various hypotheses and a philosophical foundation, our next task is to determine what kind of structure the foundation will support, and build that structure in such a way that it can accommodate and integrate the hypotheses. What we are now undertaking is, therefore, the design and construction of a theory — a general theory — of planning.

This attempt can only be made in relation to specific emphases. Thus, we shall try not to dwell on methods or techniques of application although we shall be forced to refer to these in some instances. Our main concern will necessarily be with the *elements* of pure planning theory. These are: (a) the overall domain or field of the subject; (b) the focus, that is, the prime focus, on which the theory should be concentrated; and (c) the structural or integrating set of concepts in terms of which the theory is substantified. We shall, as we go on, have to deal with some side issues. This is inevitable, and, if skill is at least vaguely commensurate with intent, such brief forays into the surrounding areas should prove both interesting and instructive.

2.

First, let us outline the general field of the subject: the topography, but even more the typology of the issues with which planning theory must deal — the field within which it must become operational.

Today, something called planning is applied — or, one should perhaps say, occurs — as part of almost any large-scale human undertaking. However, it occurs almost exclusively as a *technical* adjunct of the undertaking. Its essential functions, the formulation of policy, the real elaboration of choices and probable consequences, the definition of norms and strategies and the forcing of decisions, are virtually ignored. It is presently and primarily used to work out sequential "programs" for meeting crises that keep succeeding each other. In other words, planning has become a method for the partial ordering and, hopefully, the reduction of present complexity. Many counter-examples notwithstanding, it is not used (nor, given the current state of the art, can it be used) as a fundamental and substantive body of knowledge that has been forged into a trusted tool such as the Scientific Method, something that can be applied in the elucidation of ends to be attained and in the definition of integrated synergistic strategies that can lead to these ends.

Not only is planning today a mere technical adjunct – and an inefficient one, at that – for important aspects of decision making work, it is, like everything else, also highly fragmented.

However, with respect to this fragmentation some very interesting developments are becoming visible. Take the case of the military. Until after the second World War the "military" was a distinct, self-contained institution with clear and highly traditional functions. Similarly, military planning was a finely delineated and structured set of procedures inspired by the clearest objectives. The situation began to change early in the Cold War when the close-knit universe of the military came unravelled by all the non-military requirements of modern weapons-systems technologies, and by all the esoteric strategic concepts these same technologies brought upon the scene. As a result, what began as the Military Establishment, grew into the Military-Industrial Complex and is now evolving into the Military-Social Endeavor. (I am referring to the recent news reports that the Pentagon is intending to bring vast resources to bear on fields like education, poverty, etc.) Clearly, under circumstances of this sort the old straightforward planning procedures are evolving into all manner of related and interactive programs whose relevance to strictly military ends has become somewhat obscure, to say the least, for many an old line planner.

Aside from the military, we have the industrial – or rather the so-called "Corporate" – sector that is similarly beginning to evince interest in the socio-environmental problem areas. We hear increasingly that it is the responsibility of business to take the lead in "environmental creation"; that it would be against our traditions to let government do this, that business has the planning, management and technological know-how to put the environment back "on its feet, in a businesslike way." The *bons mots* we heard a few years ago about there being "money in poverty" were not mere jokes – they were a serious recognition of a new reality, but when stated in the traditional language of the business world they expressed an unintentional humor. The very same propensities for extension are seen in physical planning – i.e., architectural, urban, area, city, regional, etc. They are again found in economic and in administrative planning.

In every instance we might name, the same dynamics appear to be at work: a reflexive attempt on the part of each major institution to expand its planning over the space of the whole system, because no system-wide integrating force is at work in that space. As we shall see later, the absence of such a force acts against the inherent nature, structure, and organization of our social system. It is a destructive lack; and, clearly, all institutions will increasingly compete to fill this gap. This almost subconsciously motivated attempt, that of a sector to expand over the whole space of the system in its own particular terms and in accordance with its own particular outlooks and traditions, compounds the problem by further fragmenting the wholeness of the system. For sectors cannot become systems, they can only dominate them; and when they do they warp them. Hence this tendency toward the spreading of sectoral primacies over the full social space must be viewed with alarm. It is a portent, and an ominous one, of the conflicts and dislocations that await us unless a system-wide integrative approach is worked out, and unless new institutions with legitimate system-wide jurisdiction for turning such an approach into policy and action are devised.

But what are these system-wide problems our existing institutions cannot cope with unless they change or become superseded by new ones? We have to name these problems, for together they obviously constitute that large area of dissonance which is the field or domain of planning theory.

There are many ways to search for and define such problems. Most of them rely on analytical approaches and sometimes yield highly refined results; sometimes they even permit the discovery of an aspect or two of a problem, that were not visible to the naked eye. Our needs at this juncture, however, do not require us to go into fine detail. All we need is simply to have an idea of the problem-set we must work with; so what I shall do below is propose an empirically determined set of twenty-four problem areas. Such a set is clearly incomplete, but it is illustrative of the kinds of issues that confront us today. In naming these problems I have used two related criteria: (a) that they must be "systemic," i.e., system-wide in nature – or, even better, that they represent cases in the pathology of current reality when the latter is viewed as a system, (b) that they must be both "continuous" and "critical," meaning that none of them can be truly solved independently of the rest of the entire set (hence, I call them "Continuous Critical Problems" and refer to them sometimes as CCP's).

Most of these problems arise from the current, ongoing, American situation since that is the milieu I know best. Nevertheless, I did make an effort to select only those issues which, I believe, will, in the long run, grow into problems that the world as a whole will have to cope with. In other words, I have tried to define the environment – or environmental system – not in terms of this country alone, but of the entire earth. I feel we are fast reaching a point when systems limited to national boundaries will become irrelevant in the solution of major problems. It is possible, in fact, that we are already there.

When I say these Continuous Critical Problems are the "domain" of planning theory I do not mean that the creation of such a theory will cause them to be

CONTINUOUS CRITICAL PROBLEMS

1. Generalized Poverty within Affluence.
2. Discrimination vs. Minorities.
3. Obsolete Welfare Practices.
4. Insufficient Medical Care.
5. Hunger and Malnutrition.
6. Inadequate Education.
7. Inadequate Shelter.
8. Inadequate Transportation.
9. Urban and Suburban Sprawl.
10. Decay of Inner Cities (Slums).
11. Environmental Pollution.
12. Inadequate Crime Control.
13. Inadequate Law Enforcement.
14. Obsolete Correctional Practices.
15. Spoilage of Nature.
16. Inadequate Recreational Facilities.
17. Discrimination vs. the Aged.
18. Wastage of Natural Resources.
19. Uncontrolled Population Growth and size.
20. Unbalanced Population Distribution.
21. Obsolete System of World Trade.
22. Underemployment.
23. Spreading Social Discontent.
24. Polarization of Military Power.
25. Inadequate Participation in Public Decisions.
26. Inadequate Understanding of CCP's.
27. Inadequate Conception of World Order.
28. Insufficient Authority of International Agencies.

The above Continuous Critical Problems are not listed or grouped together in any particular order precisely because their very nature denies any logical ordering.

solved; nor do I mean that these and other similar problems can somehow be turned into the subject-matter of theory.

What I mean is that this large spectrum of problems constitutes a typology of issues which can be either taken together, or grouped into basic clusters, and then be acted *on, for* the purpose of changing the situation which they currently represent. If the expected change is defined as a solution and viewed as an overall betterment in this situation, then such an outcome (if and when it is achieved) might be called progress.

Thus, insofar as these CCP's are concerned, it must be clear that they are a description of the *object* on which the *subject* of the theory, i.e., planning, will be applied. In, and of themselves, these problems are not part of the theory. The subject of the theory remains to be defined beyond its name and the few hypotheses with which we started. However, before I can address myself directly to that point I must first establish the kind of "focus" my theoretic approach requires. There are several foci one could choose from but not all of them would serve my purpose equally well.

3.

On the question of *focus* we must once again be satisfied with our own inventions. There is no literature, known to me, which deals with the subject. Except in the special field of corporate planning, professional preference remains so diffuse as to be impossible to formulate. Opinions I noted in the past used to lean either toward diagnostic approaches, or toward highly analytical model-building of behavior typologies. A newer line of thinking has come up with a strong rationale supporting the reduction of large masses of empirical data into "social indicators" with, hopefully, some predictive attributes. This approach, obviously inspired by the success of economic indicators developed during and after the 1930's, is of great interest. However, the difficulties that inhere to it are awesome and very little progress has been reported to date. A still more recent tendency favors the analysis of the value implications of planning. It must, by now, be evident that I am in strong sympathy with this last trend. Yet, I also feel, and deeply, that such a focus must not be adopted to the exclusion of the aforementioned views. Both the diagnostic and the social accounting approach have their place in any seriously conceived general theory of planning that is focused on the subject's value implications. Somehow the problem must be treated in such a way that all significant approaches can be fitted together and elaborated in conjunction with each other.

There is one point regarding focus, however, on which I find myself in disagreement with a number of professional planners. This concerns a current and widespread trend to look upon planning in what I should call the "predictive mode." The attitude underlying this manner of thinking comes from the old tradition which argues that planning is focused upon the future and, therefore, must be an exercise in prediction. Adherence to this extraordinary notion also assumes – must assume – that social reality is ultimately composed of predictable events. Hence a plan's success or failure is generally measured by the question, "Did it come true? " (Obviously another way of asking: "Did you guess right? ").

This view of planning is, in my opinion, based on so deep a misconception of the nature of the future and of social dynamics that we must dwell on the problem long enough to make my own objections clear.

The "future" as an idea or operational concept has not received in recent times all the attention it deserves; nor is it always understood by everyone to mean the same thing. Cognition, experiences, thought, judgment, and decision necessarily occur in the present regardless of whether their object is the present, the past, or the future. This gives the present an overwhelming influence over both what *has been* and what *might be*. Such influence, however, is somewhat mitigated in the case of the past since what has been is, by its very nature, a highly and uniquely structured configuration of events that have actually happened. In its effort to understand, recreate or judge that past the mind is always constrained by whatever is known of that configuration, though the present provides its peculiar flavor, quality, emphases and techniques to the perception.

The future is profoundly different. Here the mind does not encounter given happenings to limit and guide it. It must, so to speak, fill the whole vast and empty canvas with imaginings, with wishes and goals and novel alternative configurations that somehow possess reality and represent shared, or at least shareable, values. Into this creative effort the present will necessarily intrude, but ideally, as in the case of the past, this intrusion should be made in full recognition that the outlooks, general views, strivings and techniques that it represents are its own.

Such an effort of conception, of imaginative *futures-creation,* is admittedly very difficult. It requires intellectual and emotional qualities of pure creativity and original synthesis. It calls for the ability to define goals and norms, to embody different sets of envisioned situations into evolving constructs, to abstract different alternatives from them, and to choose among such alternatives. It depends on one's capacity to distinguish between what is constant and what variable, and to deal with large numbers of relevant, interconnected, but causally unrelated, variables. Finally, if it is to satisfy the above requirements, the resulting construct will necessarily be different from the present state of the system and this difference must symbolize some good, or virtue, that the present lacks.

This is what I should call a *normative* approach to the future. It is an approach that has been neglected until now both because of its difficulty and because it requires habits of kind that greatly differ from those favored in our culture. The most telling of these differences probably resides in the particular notion of the "real" which our mainly technological world view imposes on us. This notion forces us to limit our conception of the real to things and events whose present operational dimensions can be measured by means of existing rules and whose future modalities can be projected with reference to those same rules. All other approaches are refuted as operationally unproved or technically infeasible – that is, as subjective speculations, dreams and unrealites. Our minds are trained to view the future in terms of present certainties and to ignore, or disvalue as irrelevant, anything that goes beyond these certainties.

This way of limiting meaningfulness has grave consequences. For one thing, it encourages us to narrow our field of vision to the confused but concrete structure of outlooks, institutions and relationships that are now in place. Further, it limits us to that particular conception of the future which is primarily informed by what we believe is feasible according to the current state of our technology. And within these limits there lies what we call *prediction.* Hence, the resultant image of such a future – of the future we say we predict – is no more than an extension of the present. The continuous extension of the present, that is, its perpetuation, is at the root of two important pathologies of our vision, one that amounts to a distortion, the other to a preclusion.

The distortion is intellectual and it governs many of our attitudes. Conceptions of the future based on linear derivations from the present tend to create the impression that there is something logically and factually inevitable in both the sequence and the final configuration of predicted events. In other words, such conceptions unavoidably suggest that the model represents some preordained reality, that has now been *discovered,* and consequently, nothing different can occur – much less, be made to occur. Belief in a preexistent natural order which can and must be discovered has great authority, for it has long been one of the supporting foundations of our philosophy of science. But when it is inspired by a model of the future instead of by nature (the object for which our science was built) there results from it an attitude which Bertrand de

Jouvenel has termed "modern fatalism" (1). Confronted with what appears inevitable, people tend to abdicate their role as creators of new and different events and abide by the dimensions and measurements which current technology has imposed upon their vision. Further, once imprisoned within such a restricted outlook, they tend automatically to act so as to make the prediction come true. The present is thus perpetuated by techniques which become strengthened and more elaborate at each step of the way – as does the feeling of impotence and irrelevance experienced by those who manipulate them. Technique-derived imperatives multiply, and increasingly restrict the areas of free choice.

Connected with this fatalism, fed by it and supporting it, there is the other consequence which I called a preclusion. What I have in mind is the preclusion from consideration of any possibility which does not fall within whatever happens to be accepted as *feasible* – that is, technologically feasible.

"Feasibility", as a criterion for direction and action in an advanced technological society, opens the door to some astonishing perspectives both by what it reveals as possible and by what it precludes from sustained discussion and serious consideration. If our technological civilization has a point, it is that almost everything is, or can become, feasible if technical ingenuity is applied in sufficient measure. Hence, most of our problems can be viewed not only as having technical origins, but also technical solutions. The range of these solutions, namely, the range of feasibility itself, is already vast. And there does not seem to be any reason why we should not make it grow further, at will.

For instance, from the vantage point of the present, feasibility promises climate control to suit regional needs; it seems possible not only to expand agricultural productivity in land areas but to use the ocean to produce both supplementary and new food resources; human presence on the moon and in space is already a foregone outcome, controle of human behavior through psychedelic drugs and other means of intervention into the brain is more than an experimental promise; so is the elimination of cancer, viral and vasomuscular disease. The automation of production is a familiar fact and its extension to distribution and exchange opens extremely interesting vistas; generalized use of computers in which I should like to call "household cybernation" is no more than a further application of automation to fields that come increasingly close to our private lives.

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(1) Futuribles Symposium at Yale University, 1965.

All this is but a sampler. These and numerous other omitted possibilities are striking not so much because they display radically new features, but because they represent, in the form of massive congeries, the constituents of today's situation. It is their inflation by future magnitudes that amazes us. Almost all we seem able to envision or imagine is more of the same, only larger. It is as if we were suddenly seized by the impulse to carry to its ultimate flowering and conclusion every circumstance, every event, every notion which present-day technology has infused with some degree of feasibility.

Such are the outcomes that populate the *logical future* (1), the future that results from prediction, the future which is the extended present. Are such outcomes good or bad? Do they represent any kind of world we would like to see happen? Is such a world what are consciously striving for?

We have no language yet, no legitimate planning conception or theory, with which to answer questions of this kind. Nor did we think, until the great disquiet of our immediate times engulfed us, that it was any business of planning or of planners to raise such questions, let alone to search for answers. Thus we have reached our current state of vast confusion and difficulty, innocent of everything but the image of the logical future engraved in our minds; having given up, among many other freedoms, the freedom to use values as an instrument of will; our eyes firmly fixed on the narrow road traced by what we know – technical feasibility – and having erased from our vision all other possible ends. In our advance along this road we have learned one thing: to respond to any challenge posed by technology with the cry "Yes, I can," and to forge ahead. This bravado, it seems to me, merely serves to confuse the issue and cover up our abdication. For, by now, surely the question to ask is no longer *"Can I? "* it is *"Ought I? "* And this takes us back to what I have called the normative approach which yields, not the ideal future or any utopia, but the willed future.

By willed future I mean that conception of the future which transcends mere feasibility and which results from judgments and choices formed with reference, first to the idea of "desirable," then to that of "betterment," both of which were mentioned earlier (2). Desirability, like feasibility, can be taken as an attribute that qualifies both ends and means. However, if desirable outcomes are viewed as capable of going beyond individual preference and, thus, of becoming conceptualizations leading to social betterment, then they should arise from larger, more varied, sets of ends than the set that is determined by feasibility alone. The range of choice must be bigger, more heterogeneous, less bound by the present, or by the authority of any particular orthodoxy. The choice of ends must be given primacy over the logical evolution of the means. It follows, then, that such futures might (and, perhaps, must) be imagined as differing radically from present reality; that they must represent situations which are not mere temporal extensions of the here and now; they must be free of the weight of what we are able simply to predict. To will a particular future state of any system is an act of choice involving valuations, judgments and decisions that pertain to the attainment of man-determined ends and to the selection of the right means (not forgetting the development of new means, if necessary) to gain such ends. In the act of willing, thus conceived, the emphasis is, however, on the identification of the ends involved rather than on the techniques that help us to reach them; hence, it should be possible to define these ends with reference to many considerations that differ from, or transcend, the boundaries of our technological world view.

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(1) I am indebted for the expression "logical future" – and "willed future" which appears later – to Dr. René Dubos, who mentioned them to me in the course of private correspondence. The use I make of these terms, however, might differ from what Dr. Dubos had in mind.

(2) See Part I, Section 4, above.

Yet, even after the dimensions of the problem have been explored, the contention remains that all our decisions are subordinate to the alternatives we are capable of envisioning; that these alternatives, themselves, are dictated by the dominant values of the present; and that, consequently, every alternative future we might conceive is a modality of the single logical future that is ahead of us – is in fact, and cannot be other than, an extension of the present.

The argument is powerful indeed. But is it tenable? We must ask this question, for if it can be validated, then the idea of willed future as I have defined it is clearly impossible to substantiate on any ground except, perhaps, that of fantasy.

It seems to me that the foregoing contention is rooted in a traditional but insufficient understanding of what we call *present* and what we call *future*. Historically, these two situations have been seen in terms of temporal succession, or sequentiality; the future being causally engendered by the present; and, obviously, the relationship between them being strictly deterministic and linear.

To realize how this manner of perceiving the future can make the future disappear altogether it is instructive to look at some of the "predictive" planning models so greatly prized a few years ago. In these models the fundamental assumptions were derived from the combination of two types of "future" event: one appearing under the guise of *risk,* the other under the guise of *uncertainty.* This approach defines risk as the quantitative measurement of an outcome (mainly profit or loss) which permits the probability of the outcome to be predicted; uncertainty, on the other hand, also represents a kind of risk but the kind one cannot measure objectively.

From these two assumptions one could (I suppose, not surprisingly) construct two models. The risk model dealt with one kind of fact; i.e., historical. And it relied on observation as its principal tool: (a) observations whose number is large enough to be considered as stable; (b) observations that are found to be repeated in the particular universe of discourse one has taken as the object; (c) observations that are distributed in the manner of a stochastic variable, etc. Such observations were then organized into data from which frequency distributions of expected outcomes could be derived. Such information, in toto, was then proclaimed a model that the decision maker could use to minimize the risks inherent in the future situation he was attempting to predict.

Now, the uncertainty model was considered to be much more interesting. It, too, dealt with one kind of fact; i.e, historical. But there was a difference. In the case of risk you thought you knew the historical facts; in the case of uncertainty you thought you did not know them. (This is quaintly referred to by saying that you don't assume "perfect knowledge.") Hence in order to calculate the measurement of facts you did not know you resorted to subjective opinions. This happened because there was not enough available data and too much change occurred in the structure of the events or in other related variables. These insights along with much reading of newspapers led to the development of the uncertainty model.

As a result our decision maker was handed two documents: the first consisted of statistics he already largely knew; the second was a report containing a set of opinions, the last of which was to the effect that one opinion being as good as another he might as well devise his own, for he was going to be responsible for his decision anyway.

When the decision maker began to look dismayed he was told that the "planning space," namely, the distance between the specific present (t^o) and specific farther and farther futures ($t^1 ... t^n$) had been delineated for him in terms of all sorts of interesting events, and that if the events did actually occur in the manner predicted he would have made a beautiful adjustment to uncertainty (achieved a state of equilibrium in economic parlance). But the deeper lesson to be derived from the exercise was that such conditions of uncertainty placed a premium on the decision maker's ability to adapt himself to continuously changing realities within the planning space and therefore he must be sure to continuously alter his expectations. This was another way of telling him that he had better operate within very short time-horizons as the validity of predictions decreases in direct proportion to the length of such horizons. When all this wisdom was imparted, everybody agreed that planning was truly an orderly way of making daily decisions about current problems. Thus having disposed of the future and placed the models on a distant shelf, everyone returned to the present, dealing with it as best they could.

So much for predictions in planning and for predictive planning in general. The inevitable and critical question now arises: Is there anyway to free us from the present – or, what can we do to *will* the future? In my view there is no more important question in planning discourse; it is truly the heart of the matter.

Let me begin by saying, "Yes, we can will the future," but only if change (as postulated in our earlier hypotheses (1) is caused to occur in values rather than in the object's other attributes.

What I mean is that any change that is not a fundamental change in values merely extends the present rather than creating the future. It seems to me that from this general postulate one can derive five statements which govern all planning.

Statement 1: *Only changes in the overall configuration of values can change the present situation.*

What this statement indicates is that the notion of planned change must be understood to mean change that is fundamental in character or, if we were to use big words, change that alters perceivable reality as well as the quality of perception. For example, the introduction of Christian values into the Roman world was a change of this kind. (Actually, all major religions belong to this category.) Again, the introduction of the Protestant/Capitalist/socialist ethos of material productivity is another case. The dedication to the scientific world view and the proliferation of techno-scientific achievement, which in my opinion represents the affirmation of our current value system, is yet another case. In contradistinction with such occurrences are those apparent changes which do not involve a basic reconfiguration of values. These would be, for example, the discovery of the stirup which allowed the Arabs and later the Mongols to conquer half the world, the printing press, the replacement of the sailing ship by the steamship, the evolution of the machine-gun, the on-going displacement of rail transport by air transport, etc. All of these are what I should call "changes by substitution or improvement." They are, it will be noticed, always and exclusively technological in nature. Such changes, in other words, do not create new reality, although they alter existing reality in very dramatic ways. They spring from the logic of already existing events; hence, they are to some degree predictable and thus it is toward them that most of what we call technological forecasting is directed.

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(1) See Part I, Section 3, above.

Statement 2: *Only individual will can bring about such value changes.*

It is evident that new configurations of values occur as insights on individual brains and then if they are accepted and successful, they undergo socialization, which is to say they spread throughout society and become accepted by the majority of people, thus establishing a new world view. This in no way supports the elitism about which we talked before in Part I. It merely stipulates that, historically, changes in value structure have come about as a result of the creative exercise of an individual's will and the propagation of this will has in turn brought about a particular type of future. In the case of substitutional changes will no doubt operates in the sense of the struggle one must conduct against existing technologies, etc. But the main point at issue is that such change patterns follow an evolutionary trend rather than the type of evolutionary discontinuity which characterizes value changes.

Statement 3: *Value changes cannot be predicted.*

I believe that this point has been very clearly and cogently argued by Karl Popper. I will adapt Popper's basic argument to my assertion as follows: Values, by their very nature, constitute a state of knowledge; hence, when we talk of a future value system we talk of a future state of knowledge. But a future state of knowledge cannot in fact be known for one can only know in the present. Hence, by the fact of being known, knowledge loses its futurity. Another way of saying this would be that if we could predict what theory would come to replace the theory of relativity, we should then not need to wait for that future theory to replace the current theory, because, by being known, the future theory would already have become current. The import of all this is that if it is true that only value changes change a situation and that value change cannot be predicted, then a predictive way of approaching the future is nonsense and the alternative way of approaching the future, namely, willing it, is the only way that makes any sense.

Statement 4: *Value changes always occur as individual ideas, or responses, or insights concerning betterment, and when they become socialized over a large part of the system we have "progress."*

What this statement claims is that the "desirability", "improvement" and even (social) "betterment" are individual ideas. They occur in single brains, although it is possible that the same idea might occur at the same time in several or a great many brains. On the other hand, what we understand by the notion of progress, which is a synthesis of the foregoing ideas, is fundamentally a social state of consciousness and the relationship of progress to planning can now be set down as a definite postulate which will govern our reasoning from now on. Namely:

Statement 5: *Planning is the organization of progress.*

I shall not at this juncture comment further on this point, but I shall come back to it at the end of the paper, which will deal which the notion of "rational planning".

Thus, everything we have said, starding with the idea of the focus of planning theory, can be concluded by repeating the following main points:

- That in planning the predictable or logical future corresponds to a lower order end whose role, within the various levels of planning we have yet to determine, must be defined;
- That the main subject of planning discourse is the *willed future;*

- That willing the future means willing a situation whose value configuration differs to a considerable degree from the value configuration of the present; again a theory of planning must define what "considerable' signifies;

- That progress represents such a new value configuration;

- That the notions of desirability, improvement, and betterment, of themselves, belong to the discourse of the logical future and that only when they are socially synthesized into the concept of *progress* does planning occur; hence planning can be viewed as being that conscious and rational synthesis;

- That this new value configuration must be conceived of first in terms of the ends to be achieved, and that only afterward should consideration of the attainability of such ends be introduced into the discourse;

- That in this manner of proceeding the dynamic of planned change follows a course which is not always obvious but which is of great importance. Namely: that the point of planning is to change the present to fit the image of the willed future rather than to project the present into a conception of the future which is derived from the logical vectors that happen to inhere to it.

This last point is so important that I must clarify it. In orthodox planning, the present defines a particular *here and now* and the future defines a particular *there and then.* Time is viewed as flowing from the here and now to the there and then; hence the future is clearly caused by the present – a straight and deterministic causal relation that makes the future predictable (the only difficulty is that the present, being overly complex, such predictions are not easy to make). What I have propounded is very different. In my view the present is the here and now and the future is another imagined and different here and now. Time need not be seen as flowing but as a space. The present is *the* here and now as it, in fact, exists. The future is *a* here and now that can be willed. And, planning is that activity whereby that which can be willed is imposed on that which is – and imposed with the purpose of changing what is into what is willed. Thus if time must have a direction, or a flow, it is exactly the contrary of what is generally believed, for it flows from the imagined future toward and upon the experienced present.

Thus, in our planning discourse what we have earlier called the *object* is the *present;* what we have called the *purpose* is embodied in the *values* with which we have infused the *willed future.* And these values have been conceived in terms of certain ends in which the notions of desirability, improvement, and betterment are synthesized through planning into the social idea of *progress.*

4.

With the problems of theory domain and theory focus out of the way, we are now ready to design and set down an *integrating construct* which will subtantify, hold together and make operational the whole theoretical framework. This construct is, so to speak, the heart in the heart of the heart; the machine that makes a machine ; the rationale which renders rationality rational. In other words, it is a metaphor. And the point is, it has to be the right metaphor, because different conceptual schemes have been known to react favorably to different metaphors. Celestial bodies have done well in being viewed as parts of an immense clock; temporal reality has long been the river into which Democritus once waded; Newtonian relativity never really freed itself from the movement of His Britannic Majesty's ships; we all know that gravity is a falling apple, etc. These metaphors are solid indeed, but somewhat coarse. On the other hand, the "unconscious" was quite a *tour de force;* so was Pascal's "wager"; and so was the vision of "evolution", and, so far as it went, was the notion of atom as the constituent unit of matter. From all these metaphors grew extraordinary insights, and from these insights, theories, which – whether they were right or wrong – deepened and broadened our knowledge. Therefore, we now need a metaphor for planning.

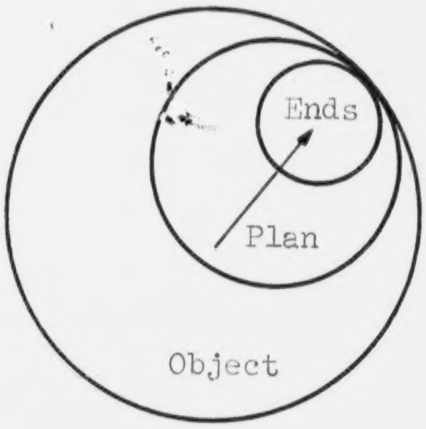
Actually, twenty or so years ago, planning did possess such a metaphor; it was a car trip. To be more precise, it was a trip from New York to Boston, or rather to Cambridge. Many industrial managers, to my knowledge, were introduced to the subject by means of this extremely hazardous journey. I should add that it wasn't a bad introduction and it used to appeal greatly to those who make a profession of being practical: cars and roads and horrendous traffic conditions and alternative itineraries and falling barometers and the importance of getting there on time and ahead of your competitors... meant a great deal to those people.

Yet good though it might have been, it still was somewhat primitive, and I think it has been dropped. We shall try something a little more abstract and flexible, something more in tune with our increasing sophistication. We shall try to use the notion of *system* as our central construct.

It must be clear from the opening discussion of the nature of planning, of the first hypotheses we have established, of the value problems we have identified, of the field and the focus we decided to adopt, that all our concerns were explicitly or implicitly, but always almost inevitably couched around, or in terms of, or with reference to, the all-pervading idea of *system*. It might, therefore, be useful to clarify certain aspects of this most interesting and versatile conceptual tool.

Since the general principles of system discourse are widely known, it should be sufficient to begin by indicating the manner in which I shall apply them to planning.

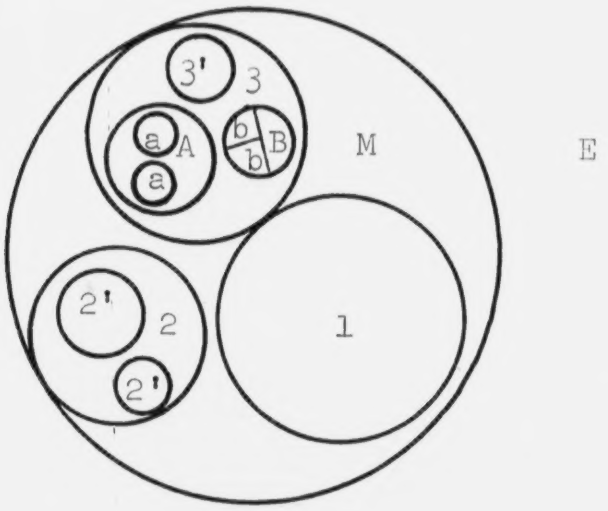
It is one of the peculiarities of planning activity that it cannot be wholly abstracted either from the object on which it is meant to act, or the ends for which it is being construed. Therefore, we must begin our theoretic approach with reference to three main points that are almost impossible to separate, even to make their discussion easier; these points being: (1) the ends, (2) the plan, (3) the object. The way these three points stand in relation to each other could, perhaps, be best portrayed as follows:



However, as it is not possible to discuss three different orders of reality simultaneously, I will assume for a moment that ends are subsumed under plan and then proceed to deal with the plan's and the object's governing characteristics.

The first point to be noted at this juncture is that we are now confronted with two systems one of which being the plan, and the other the embedding situation of the plan. I shall refer to this latter system as the "environment".

Both plan and environment are discrete systems, although the plan being contained in the environment could be viewed and treated as a sub-system. Further, it is possible that it should be. Nevertheless, semantic confusions appear probable and I feel that it would be helpful briefly to indicate graphically the convention I shall use to distinguish between hierarchies of system. Thus, given the following relationships



if, as is customary, the concept "system" is taken as the base, or tool-concept, then the relations in the above graphic can be ordered as shown in the table.

SYSTEM RELATIONSHIPS

If \ Then	Sub-System	Meta-System	Environment	Beyond Discourse	Other Systems
1 $\equiv$ System		M	E		
2 $\equiv$ System	2'				
3 $\equiv$ System	5'	M	E		
A $\equiv$ System	a	3	M	E	3' and B
M $\equiv$ System	1, 2, 3	E			
E $\equiv$ System	M				
a $\equiv$ System	undefined	A	3	M, E	3'
B $\equiv$ System $\longrightarrow$ b $\equiv$ $\left\{\begin{array}{l}\text{system element, or}\\ \text{system component, or}\\ \text{system sector}\end{array}\right\}$ other aspects are analogous to A $\equiv$ System					

In terms of the foregoing relationships, I shall generally view the environment as the meta-system and the plan as a discrete system within it. This will permit me to deal in some depth with the important question of the internal *structure* of both these entities.

5.

I shall begin by discussing the characteristics and the structure of "environment".

Environment is a general term used in many different ways, depending on its context. Without some explanation, it is almost meaningless. On the other hand, its very generality gives it flexibility as a concept and this is helpful in that the term lends itself to manipulation and usage at different levels of discourse.

For my purpose in this paper, I shall use environment, without repeated qualification, as that which planning acts *on,* while at the same time being a part of it. Apart from this general condition, I will describe the structure of environment in empirical and in systemic terms.

In *empirical* terms I call environment the entire experiential milieu of man. This encompasses nature in all its dimensions, society, institutions, and the multiplicity of artifacts which man has created through his technologies. It also encompasses the intangible aspects of experience we call cultures, ways of life and all manner of informal relationships, both in time and space. History, therefore, as well as the accumulated memories of peoples enter into this general description, as pertinent or as required.

So large an array of elements clearly needs some ordering if one is to talk about it meaningfully. It might be useful to make certain couplings and distinctions such as *life/nature-centered environment,* or *social/human-centered environment,* or *thing/technology-centered environment*, as long as we remember that these are arbitrary constructs. Reality does not abide by such distinctions; we experience reality in the form of an immense ecology within which all the aspects of the environment intermesh, interrelate, interact, change, and balance in that particular way that we call "dynamic".

The life/nature-centered environment is both human and natural. It is people in relation to air, earth, water, mountains, plains, forests, and so forth; people in relation to non-human life; people in relation to the seasons and the climates of the world; people in relation to all the complex mixtures of these that one finds in different places of the globe, which ultimately is itself the environment we are talking about.

The relationship of people to the life/nature-centered environment is taken for granted because it is almost one with living. Today, however, a situation is beginning to develop in which this taking for granted is no longer possible because the relationships which link man to the natural environment are being disrupted by all kinds of forces of man's own doing. I am talking mainly of two major disruptive events, one of which is increasing population densities, and the other the imposition upon the earth of our technological creations to such a degree that they have become another dimension of the natural environment. Combined population increase and technological encroachment have caused us to destroy forests, flood deserts, change climates, divert rivers – to create more farm land, to build more factories, more houses, more roads. They have caused us almost entirely to eliminate wildlife in our competition with them for food and for space. They have caused us to subjugate animals and plants to serve our techno-economic purposes. In the name of these same purposes we use the natural resources in such quantities that their normal replenishment can no longer subvene to our needs and it is possible that in some foreseeable, not too-distant future we shall have exhausted even the possibility of substitutions at which we have shown ourselves to be so imaginative and clever. Along with this expenditure of wealth or capital, in the true sense of the word, goes the reckless expenditure of space: dwellings, factories, highways, airports occupy, as they must, more and more of the open environment in which the human race evolved. Many of these occurrences happen not merely through direct expenditure and wastage – they are also accompanied by spoilage of what is left and what has been put up instead. Ugliness is spoilage; discomfort is spoilage; pollution is spoilage. In the case of the latter, pollution of both the air and the water is fast becoming an extraordinarily massive feature of our environment. A problem with whose human and natural consequences it is not yet certain that we know how to cope.

All these happenings, when noted in their frightful cumulation, suggest the question of whether the human being is not going to be suffering in a most grievous way from his continuous intervention in the ecology of the life-nature-centered environment. This is a question which we often hear couched in the inflated language of political concern. But we seldom listen when it is voiced in terms of the real dimensions of the catastrophe, namely, in biological and psychological terms (1). In the idiom of these serious discourses we find that the focus as well as the import of the question changes. It is no longer the specious query wondering if human ingenuity will eventually fail in its ability to give techno-scientific answers to growing ecological disruption. We need not doubt our abilities in these fields. Our inventiveness here has a momentum all its own; it is as one used to be able to say in the past "blind and powerful like a force of nature". The real question is, are we going to succeed in adapting ourselves fast enough to the thing-centered, the technology-centered environment that will have replaced the life/nature-centered one? For, the fact remains that human beings are themselves entities possessed of physiological, biological and psychological attributes with extremely precise characteristics. These enable them to adapt to changes in the natural order; namely, to changes that are slow and gradual. But there is nothing in the human make-up permitting the conclusion that we can adapt ourselves, beyond certain ranges and boundaries, to the rapid and complex changes of a man-created order. What we know on this subject would seem to argue against such a conclusion. For what we know indicates that, while our ways of life and even our social organizations have greatly changed since our arrival upon the scene, our physiological and psychological requirements do not seem to have changed. And, if man possesses a basically unchanging make-up, one that is required for certain particular modes of adaptation to certain particular types of environment, we must give very serious consideration to how he will react to an environment that is changing at headlong speed and in quite contrary directions to that within which the human species has evolved.

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(1) See René Dubos, *Man Adapting*, Yale University Press, New Haven, 1965, as well as almost everything else that Dr. Dubos has written.

Now, it is possible to argue, and the argument has been advanced, that genetic evolution will take care of this problem. Yet, we know that genetic change is much too slow to permit the kind of effective adaptation we need to remain consonant with our thing-centered or technology-centered surroundings. There is no doubt that there are certain limited kinds of adaptation of which we are capable. But, in these cases, insofar as I am able to understand the point at issue, we are not talking of true adaptation, but of adjustments – of tensions and of being stretched out of shape. The trouble with such adjustments is twofold: they have extremely narrow ranges; and, they come for a very large price. The range is the amount of stress the individual can bear; the price is the multiplicity of psychosocial as well as psychosomatic diseases of all kinds with which we are increasingly afflicted.

These many maladjustments bring me to the third aspect of environment which we are superimposing upon the natural and the technical, and that is the social/human milieu of today. The dynamics of this milieu is extremely interesting to observe in the light of what we have just said. We now live under conditions of growing pollution, of intense crowding, of deficient diets, or imbalanced diets, or surfeiting and otherwise destructive diets, of monotony, of ugliness, of discriminations, of general boredom and of all sorts of other social dissonances. Throughout the world the most polluted, the most crowded, the least comfortable, the most difficult to survive in cities (Calcutta, Hong Kong, New York, etc.) are also the ones where the population is increasing most rapidly due both to direct birth rate and to migration from the surrounding countryside. This particular imbalance has probably more than one profound lesson to teach us, but the most blatant of these lessons is: we have so structured our social/human environment that conditions of dehumanizing stress and non-human crowding do not seem to constitute an obstacle to the pursuit of wealth, to production, to economic development. On the contrary. It is in such centers of pollution, of disease, of intense environmental dissonance that we find much of our wealth being produced, and it is being produced by people working in physical conditions difficult to imagine, by people working amid destructive noise, by people working under great and constant nervous tension, by people competing for bread, for rice, for shelter, even for a piece of street where they may stretch out for the night, and in atmospheres contaminated by all sorts of pollutants. Not only are the conditions of work bad but the unplanned sprawl of our cities, of our wealth producing centers, has taken such proportions that pollution, nervous tension, risk to life and limb are now generalized conditions. They occur long before we reach the place where we produce the wealth for we must commute to that place from ever-increasing distances, for hours on end, and in ever worsening circumstances of traffic and miscellaneous wear and tear.

So much for the present and expected empirical dimensions of our environments. In their daily experienced details, these dimensions add up to one fundamental phenomenon: our ecology has entered into a phase of *overall dissonance* with human biology, physiology and psychology.

This fact in itself is extremely grave, both for the present and for the future, and if any of the points we made earlier about planning are warranted, then it is clear that rational change – namely, *planned change,* must address itself to the readjustment of our ecological base and to the reestablishment of a long-lasting consonance between our general environment (in terms of life, nature, things, technology and society) and the human being.

Such consonance is a fundamental relationship between two interactive systems –i.e., between environment seen as a system and planning as a system. To be able to introduce this relationship into the reasoning we must first make certain abstractions from empirical details which are too numerous and rich and confusing. This work of abstracting is outlined in the next sections and has two main objectives: (a) that we might be able to introduce the idea of "environment" as a tool-concept into our theoretic construct; (b) that we might come to understand how the activity we have called planning might be made to impinge on the situation and deflect its dynamics toward ends that are more consonant with the make-up of the human being, or, at least, toward ends that are less dissonant with it.

6.

In the ensuing pages I shall explore various characteristics and properties of the environment in terms of the following systemic dimensions: (a) system boundaries, (b) characteristics of human systems, (c) properties of open systems, (d) the notion of feedback.

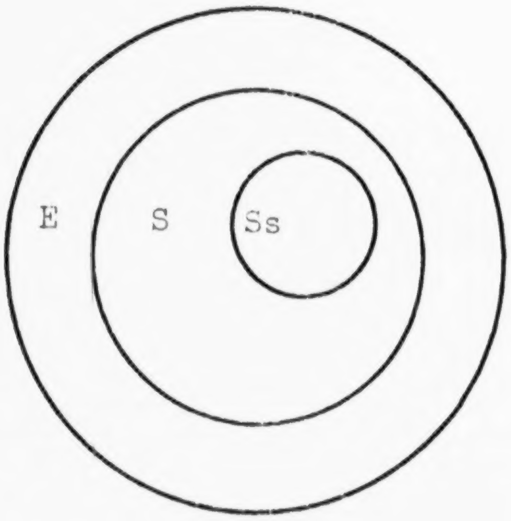
The establishment of the *boundary* of a system is necessarily arbitrary. If,however, we define our conventions (linguistic and other) and are consistent in our use of them, we can abstract a workable notion of boundary from the general concept of system.

Systems may be considered "closed" or "open" depending on whether they interact across their boundaries with their environment, but to determine which, it is obvious we have to have some idea where (or when) the system ends and the environment begins. This is an elusive quest. If we imagine reality as a series of sytems contained one within the other and consider living organisms as systems it is obvious that the system which contains them must sustain them. From this, it follows that all organismic systems – this, by the way, being the descriptive metaphor we will use to characterize "human systems" – are *open*. However, if we push encompassing systems to the ultimate it is clear that the final and all embracing one can only be the universe. This complicates the question of open or closed, for right now the notion of the expanding (open) universe is being challenged by recent space explorations which indicate the universal system may be closed. If it is, it would simply mean that all "open" systems are, in ultimate terms, closed.

Furtherance of our discussion of the dynamics of planning, however, does not require us to consider the universal or ultimate environment. The environment which provides a sufficient totality is that comprised within the boundaries of the earth system. And, although within this totality the environmental aspects with which we have to deal directly must be *whole entities,* they can be empirically specified (as we have previously done) under three headings: life/nature-centered environment, social/human-centered environment, and thing/technology-centered environment. We must now select from these environmental entities the one most pertinent to planning discourse and interpret it as a system.

Since planning as purposive human activity takes place within a social context, it follows that its context – its environment – is that which we have already defined as the *human/social.* It is this portion of the empirical environment whose systemic properties must be established.

The boundaries we shall deal with are, therefore, set as follows:



If S ≡ System ≡ Human/Social-centered aspects of environment,

then E ≡ Environment ≡ Life/Nature-centered and Thing/Technology-centered environments,

and Ss ≡ Sub-system ≡ Planning.

Here, we should note that following accepted usage, I shall call *variables* all the factors that are endogenous to the system (S) and affect it from within, and call parameters all factors that are exogenous to the system and affect it from the outside, which is the same as saying from the environment (E). It is with the properties of (S) that we are concerned.

In selecting the governing metaphor for (S), "the human/social system," we find a considerable consensus that this type of system is fundamentally *organismic* in nature and can be described through the attributes of organismic models. Now, having a metaphor, we can derive the characteristics and properties of (S) with reference to a given level of abstraction.

With reference to such attributes the following characteristics need to be noted:

1. Human social systems belong to the class of "open" systems, meaning that they interact with their environment. This interaction takes the form of an exchange of matter, energy and information which derive both from the system itself and from the environment. Such exchanges take the form of inputs and outputs. *Input* is defined as any event occurring in the environment that alters the system. *Output* is defined as any change caused in the environment by the system.

2. The behavior of human social systems is typically purposive. Generally, behavior can be classed as of two main types: random and purposive. *Random behavior* is activity which cannot be interpreted as directed toward a goal. *Purposive behavior* is activity that may be interpreted as directed toward a goal – namely, toward a "final condition in which the behaving object reaches a definite correlation in time or in space with respect to another object or event (1).

   Thus in this sense "the basis of the concept of purpose is the awareness of 'voluntary activity' (1). This definition of purpose might sometimes be found too restrictive, as it should be possible to recognize that some orders of purposeful activity could have subconscious roots, in which case the "awareness" noted above would be lacking (at least in conscious form). Hence, ranges of behavior going from the unconscious to the conscious, and from the non-rational to the rational will be accepted as purposeful in the case of human social systems. *Irrational* behavior, on the other hand, will be considered as random activity.

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(1) A. Rosenblueth, N. Wiener, J. Biegelow, "Behavior, Purpose, and Teleology" in *Modern Systems Research for the Behavioral Scientist, Walter Buckley, ed. Aldine Publishing Co., Chicago, 1968.*

3. Human social systems, including subsystems such as individuals and groups within them, interact in the form of a dynamic that tends to lead to a steady state situation (1).

4. Human social systems tend to resist disruption of the steady state.

5. Human social systems are, within definable and relatively narrow limits, capable of adjusting to changes internal and external (environmental) to the system. However, they also possess the characteristic of *creativity* by which we mean that they can both adapt to their environment and interfere with it, thereby changing it so that they might be able to adapt to its altered form.

6. In human social systems there exist certain typical processess which tend to become mechanistic over time; i.e., which, after a certain time, tend to operate in the form of fixed arrangements.

7. In human social systems energy is quite uniformly distributed, and not very mobile. This stands in noticeable contradistinction to mechanical energy, which, because of relatively large differences in potential, can be mobilized rapidly (2).

8. Human social systems are reproductive, and insofar as reproduction can be viewed as a purposeful activity, the continued – hence future – existence of the system becomes a rational consideration (or decision) in such systems.

9. Human social systems display something called "functional unity". This refers to a condition in which all the parts of the system work together with a certain degree of harmony or internal consistency, and without producing persistent conflicts which cannot be resolved or regulated (3).

In setting down these characteristics of human social systems I was forced to use a number of expressions such as "open system", "steady state", etc., which refer to important *properties* of sytems. I shall now elaborate on certain of these properties, in the hope of shedding further light on the nature of human social systems.

(1) The term "steady state" will be defined further on.

(2) Rosenblueth, Wiener, Bigelow, *Op. Cit.*

(3) On this important point, see A.R. Radcliffe-Brown, "On the Concept of Function in Social Science," *American Anthropologist* (New series) 37, 1935.

There are two generic types of systems: *closed systems,* which are isolated from their environment and, therefore, do not interact with it. One of the most interesting properties of closed systems is that they operate in accordance with the second law of thermo-dynamics, which postulates that a quantity called "entropy " or degree of *de-organization* in the system tends to increase to a maximum, that is, toward homogeneity or better, toward the levelling of internal differences. This state is also called a state of "equilibrium".

Open systems, on the other hand, are, as I have noted earlier, those which interact with their environment, through the exchanges of matter, energy and information. However, open systems have other extremely important properties, such as the following:

1. In open systems *entropy* tends to increase, that is, the dynamics of entropy tend to be more intense.

2. However, open systems are characterized by another force, namely, *organization* and this not only counterbalances the tendency toward de-organization but operates toward the achieving of higher levels of orderliness and heterogeneity. Hence, we must realize that in open systems entropy as well as organization operate and must somehow be made to match in a positive outcome.

3. When an open system attains a balance of a higher order the result is not equilibrium but *steady state* dynamics, which means that inflow and outflow balance each other and that the system continues to maintain its on-going rates of change. Hence one could say that in open systems the steady state represents a dynamic interplay of subsystems which are operating as functional processes.

4. Open systems are *self-regulatory* and *self-adaptive.*

5. Open systems are *not deterministic,* namely, they have a property called "equifinality", which means that as part of their self-regulation they tend to achieve and maintain a steady state around a particular stage or level (i.e., goal). Another way of saying this is that these systems are capable of achieving the same results while starting from different conditions.

6. It follows that open systems are *non-causal* in their dynamic and operating characteristics.

7. Open systems display major *feedback* functions.

The concept of "feedback" is of central importance, both in systems discourse and in planning. Hence, it is necessary that we try to understand it in some depth.

Norbert Wiener initially defined feedback as "...the property of being able to adjust to future conduct by past performance" (1). Another important definition is found in Hall and Fagen: "Certain systems have the property that a portion of their output or behavior is fed back to the input and affects succeeding outputs" (2).

The pertinence of feedback to planning lies in its close connection with "futurity" and "goals", and also in that it is a powerful "control" concept.

I shall, therefore, borrowing from and liberally paraphrasing the famous article of Rosenblueth, Wiener and Bigelow (3), describe the major traits and properties of the notion of feedback:

1. "Purposeful active behavior may be subdivided into two classes: 'feed-back' (or 'teleological') and 'non-feed-back' (or 'non-teleological').
2. Feed-back may be either positive or negative, and it is in the latter sense that feed-back acts as a "control". The behavior of an object can be controlled by the amount of its deviation from a particular goal at a particular time. When such a "margin of error" occurs, the feed-back signals from the goal become negative; they inhibit outputs which would overshoot the goal.
3. These signals from the goal guide behavior. Feed-back keeps purposeful behavior on course by reacting to the amount of its deviation from a particular goal. All purposeful behavior requires negative feed-back at some time or other if it is to attain its goal.
4. Negative feed-back is restrictive, positive feed-back augments; "...it adds to input signals, it does not correct them." (This is sometimes referred to as the "amplification effect".)

With these important characteristis and properties established, we can proceed to the next section where we shall similarly explore the nature and structure of "plan" seen as a system.

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(1) N. Wiener, *The Human Use of Human Beings*, New York: Doubleday Anchor Books, 1954.

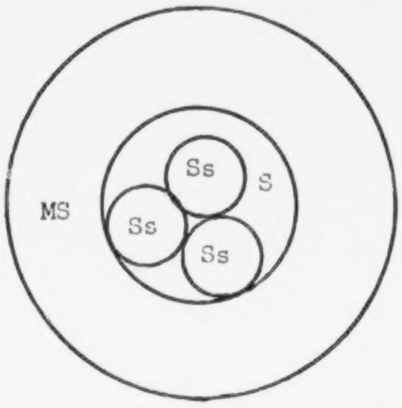
(2) A.D. Hall and R.E. Fagen, *"Definition of System," Op. Cit.*

(3) *Op. Cit.*

7.

Now to planning. Planning is, *sui generis,* a human social activity which is designed to act *on* the environment *for* the purpose of changing it in such a way that tendencies toward coherence and cohesion are enhanced and tendencies toward disintegration and dissolution are kept under check. In other words, planning is a process whose function is to reduce entropy and increase organization within the environment.

To find out how this function is exercised, we must try to understand the manner in which planning and environment relate or interact. Having defined planning in general as human activity, we can proceed by assuming that it, too, like environment, might be amenable to description as an organismic model. It is this assumption that I shall explore first to try to develop a language that can describe the relationship and permit us to see planning as a system. To begin with, I shall call the environment in its totality the meta-system that encompasses planning. Thus:



If S Ξ System Ξ Planning as a general instance of human activity

then MS Ξ Meta-System Ξ Total Environment, including Human/Social, Life/Nature and Thing/Technology Centered environments

and Ss Ξ Sub-Systems Ξ Component elements of Planning.

In the light of this configuration, I shall proceed by observing the basic relationships between S (planning) and MS (environment as meta-system) in terms of the 9 characteristics and 5 properties we have recognized in the preceding section as pertaining to organismic models.

1. *Boundaries.* At first look planning unquestionably appears to be an open system for it consists of boundary-crossing actions that aim at changing the environment, either in whole or in part. The environment in turn acts upon planning, it provides the values, purposes, directions, and technologies that inspire and guide it. Such inputs are given to planning by people acting as people, rather than planners or planners alone. Clearly there is input/output exchange in terms of information and, of course, when plans are enacted they affect individuals, institutions, natural surroundings, etc. On the other hand, once the environment has provided the inputs, the operational aspects of the plan may, in some cases and at some levels of discourse, become self-contained, and the plan's jurisdiction may become limited to the space of its system. When this happens the plan should be viewed as a closed system. Hence, we must conclude that we have in planning a system which is both open and closed, depending on the level being observed and on operational circumstances.

2. *Behavior.* With respect to behavior, planning can be described as rational insofar as rational is defined as intellection performed according to particular rules. If planning is rational, it follows that it must also, to a great degree, be conscious. However, once the rules have been set, the procedural aspects of planning may become so routinized as to be virtally automatic or unconscious. Planning behavior is always purposive in that it aims at achieving a given goal or goals, but planning behavior is only purpose*ful* to the extent that it is voluntary action. Its behavior may be called non-voluntary or involuntary when goal selection is made not by the environment as a whole, but is imposed from above by sectional interests or some overriding authority.

3. *Steady State.* The manner in which planning contributes to steady state dynamics is complex and ambiguous. On the one hand, planning is a conglomerate of activities that aims at keeping the steady state in the environment through the attaining of goals and through long-run action patterns. Planning can function so as to bring counter-disruptive influences into play when the environmental meta-system is threatened by dislocations and imbalances. Planning, when viewed as an open system with a lively flow in inputs and outputs that interact in such a way as to keep the system functioning, can itself be an expression of the steady state. However, when planning becomes a close, self-perpetuating and self-corrective (cybernated) system it does not generate steady state that applies to the meta-system although it may attain a steady state in terms of its own limited system space. In other words, it creates localized steady states.

4. *Resistance to Change.* We know that human social systems tend to resist disruption of the steady state. With regard to planning, it is evident that, per se, planning need not be resistant to change. All plans can, theoretically, be changed at will. Moreover, we have hypothesized that planning induces change; this being ultimately its main function. Thus, under the present heading, we must conclude that planning is not resistant to change, while at the same time it can be change-creative. Nevertheless, we know from experience that both plans and human attitudes that underlie planning often become rigid, especially when they grow institutionalized (the role of the German War Plan in the mechanically ordered events leading to the opening of hostilities during the first World War is a classic instance of this). *Therefore, it is necessary to add that under certain circumstances planning* becomes highly resistive to alteration, and it seems permissible to surmise that this occurs mostly at those levels where plans operate as closed systems and therefore become unable to respond "on-time" to the requirements of the environment.

5. *Adjustment to Change and Creativity.* We have observed that human social systems adjust to environmental change within relatively narrow limits. By the same token, planning is adaptive to evolution in the environment only insofar as continuous exchanges between it and the environment permit it to operate in an adaptive mode. More often, however, again because of growing rigidity and institutionalization, plans become non-adaptive and tend to lose touch with surrounding evolutionary trends.

   Similary, we have said that one of the basic characteristics of the human social system is creativity – this notion being defined as the ability to change the environment in such a way as to make adaptation to it easier. Planning, by definition, is that activity which should be causing this kind of change in the environment so as to permit human adaptation to occur without inhibitive dislocations, and this indeed does happen in particular instances of planning activity. Nevertheless, in plans that are closed there is a tendency to become rigid, automatic, and self-perpetuating. This is another example of a plan's failure to relate to the environment and thereby to lose its interreactive capabilities. When this happens planning can be said to have become non-creative and sterile.

6. *Tendency toward Routinization.* We have noted before that there exist in human social systems certain processes which tend to become mechanistic over time and therefore to turn into routines. This is precisely what happens in plans that are of the closed type. Planning which is addressed to the expedient solution of particular classes of problems often ends up by

becoming entirely routinized. This is due to the fact that very strong propensities exist to economize energy by repeating successful solutions over and over again.

This tendency is so powerful that no planning is wholly free from it. Hence, what we must conclude in this instance is that even the most creative and open type of planning often inclines to develop fixed arrangements and thus to become at least partially routinized.

7. *Energy.* Energy in human social systems was seen to be widely distributed and slow to mobilize. Planning, on the other hand, often acts as a concentrator and mobilizer of energy. In this sense it is very similar to a machine. Even in the case of plans seen as open systems this feature is visible because the relatively rapid concentration and mobilization of energy is one of the fundamental functions of all good planning. Here the main point lies in the fact that energy is strategically concentrated and not distributed over the whole space of a plan. Given the universality of this phenomenon, it might bear repeating that this is an extremely interesting mechanistic aspect of almost all types of planning.

8. *Reproductivity and Futurity.* It is self-evident that plans not being biological organisms do not reproduce themselves in the sense human beings do. The characteristic of "reproduction" does not apply to planning, except metaphorically speaking. When we translate the concept of reproduction into that of futurity, namely, into the principle of continuity, then we definitely have a characteristic that does apply to planning. It applies in two important ways: (1) Insofar as futurity is concerned, it is one of the basic definitions of planning that these activities are addressed to the future and embody future-oriented decisions rather than decisions that are oriented to the immediate present. (2) Insofar as continuity is concerned, plans do tend to become self-perpetuating, especially when they are institutionalized. This is another aspect of the rigidification we have encountered above. The more closed a planning system is, the more it tends to operate in a way that assures its perpetuity. This feature, inasmuch as it contradicts the principle of change that most profoundly justifies planning, must be viewed as one of the gravest pathological characteristics of planning and of plans.

9. *Functional Unity.* With respect to functional unity, by which is meant the ability of parts or subsystems to work together harmoniously and with internal consistency, this characteristic is definitely one of the fundamental functions of any level of planning. Not only is planning aimed at insuring a situation of harmony in the meta-system, but the very fact that it, itself, is a

logical construct makes it a *sine qua non* condition that planning must, by definition, satisfy the requirement of functional unity.

Yet, this is not always the case. And we find ourselves confronted with the great problem of system space, namely, of a plan's given area of jurisdiction. Thus, if within a given environment there are several plans that operate in parallel over contiguous spaces, each of these plans might well have total functional unity within their individual jurisdictions. But, insofar as the whole environment, or the meta-system, is concerned, it is possible and in fact highly probable that no overall functional unity will be achieved. This results from a conflict of goals, when such goals are provided for different plans without consideration of the higher level requirements of the meta-system as a whole. When such a situation prevails planning, even though it may be internally consistent and functionally unified, ends up by being destructive of the overall functional unity that is needed in the environment. This phenomenon almost always accompanies what we have earlier termed sectoral planning which ignores the needs of the whole system.

From these various characteristics, we can now go on to develop a similar comparative analysis of the various system properties that were listed in Section 6, above. Thus:

1. *Entropy.* The organismic model of the human social environment displays strong tendencies toward entropy which are in most cases overcompensated by the forces of organization. In planning, seen as an organismic model, the notion of entropy, per se, need not pertain. What does pertain, however, is that, depending on whether the plan is at the level on which it is closed and mechanistic, or open, what we encounter is either something we might term fixed organization or, in the second case, a tendency toward higher levels of organization. Thus, depending on the level of planning we are considering, we might see a machine-like, repetitive, organization that is at work; whereas in higher types of planning we will see the creativity we noted earlier operating – the tendencies toward change and disruption being counterbalanced by ever higher modalities of organization.

2. *Self-Regulation and Self-Adaptation.* Human social systems are self-regulative and self-adaptive. A plan at its lowest mechanistic level can also be self-regulative and self-adaptive in the sense of being *cybernated.* However, at its higher functional levels it operates in the organismic mode and becomes self-regulative and self-adaptive, in the conscious sense – thus reflecting the events of the environment. At still higher levels, it can be said

that the function of planning is precisely the function that dictates the modalities of self-adaptation and self-regulation that the environment achieves, by stipulating the rules that govern change.

3. *Equifinality.* Human social systems are non-deterministic. Plans, when they are closed and mechanistic in nature, are entirely deterministic. On the other hand, at higher levels, they become like the organismic environment, non-deterministic and completely flexible. In other words, at these levels the concept of equifinality applies to planning.

4. *Causality.* The very fact that the human social system is non-deterministic also indicates that it is non-causal. Hence, the very fact that lower, closed planning systems are deterministic make them causal in character, while the higher, open planning systems are non-causal.

5. *Feedback.* In the human social environment feedback is goal-derived. In closed planning systems feedback is also goal-derived, but cybernated in the sense that it is organized to react in pre-determined ways to given deflections from the goal. Here reactions are comparable to following automatic instructions which come into play when the behavior required of the plan deviates from its programmed course. Feedback in higher-level open planning systems is goal-derived in the same sense as in the environment. However, goal derivation in these open systems is perhaps more explicit than that in the environment as a whole; and feedback, in such systems, is also end- and value-derived.

These comparative points are reduced to a synoptic table on the next page.

What appears to be very interesting in this listing is that the organismic assumption about planning reveals profound contradictions. This is a clear indication that the metaphor we have postulated is insufficient and cannot accommodate all the modalities encountered in planning as a system. It follows therefore that in planning we have something more than an organismic model. Moreover, it appears that planning symbolizes two sets of principles which regulate the behavior of the environment – from the outside, so to speak. From the characteristics and properties that were recorded we see, for instance, that at some levels of discourse, we have a system that is akin to a machine, while at other levels the view changes and planning becomes better understood in terms of a system that is a *model of human action.* It might be important to remind ourselves at this point that machines and concerted human action are very similar in some respects and very dissimilar in others. On page 118, another table will be found in which this distinction has been detailed.

SYNOPSIS OF BASIC RELATIONSHIPS BETWEEN PLANNING SYSTEMS AND THEIR ENVIRONMENTS OR META-SYSTEMS

1. *Boundaries:*	Higher level planning systems interact openly with the environment; lower level planning activities may be closed.
2. *Behavior:*	Planning is rational and goal-directed. It is voluntary when goal selection is free rather than imposed by sectional interests.
3. *Steady State:*	Higher level, open planning achieves environmental steady state through attainment of goals and long-run action; closed planning may achieve only localized steady states.
4. *Resistance to Change:*	Planning is not resistant to change and may be change-creative, but when it is a closed system it may be unresponsive to requirements of the environment.
5. *Adjustment to Change and Creativity:*	Planning may be adaptive and creative to the extent that it permits continuous exchange with its environment.
6. *Tendency toward Routinization:*	Whether open or closed, planning tends to develop fixed arrangements and at least partial routinization.
7. *Energy:*	Planning acts as a concentrator and mobilizer of energy.
8. *Futurity:*	Planning embodies future-oriented decisions, but as a closed system it tends to perpetuate the present.
9. *Functional Unity:*	Higher level planning is aimed at insuring harmonious working of the parts and overall unity of the total system, but dispersion may lead to disharmony and neglect of requirements of the system as a whole.

SYNOPSIS OF PROPERTIES OF PLANNING SYSTEMS

1. *Entropy:*	Planning tends to reduce entropy through routinization or the introduction of higher levels of organization.
2. *Self-Regulation and Self-Adaptation:*	Planning at different levels achieves varying forms of self-regulation and adaptation, ranging from pure cybernation to anticipatory response to events.
3. *Equifinality:*	Closed planning is mechanistic and deterministic; at higher levels it consists of non-deterministic human action.
4. *Causality:*	Closed planning is causal; higher, open planning systems are non-casual.
5. *Feedback:*	Feedback in planning systems is goal-derived and varies from pre-determined reactions in closed systems to flexible, creative adaptation in open systems.

GENERAL CHARACTERISTICS

Mechanistic Model	*Human Action Model*
Goals given from outside.	Selects values, invents objectives, defines goals.
Designed to solve specific class of problems.	Seeks norms, defines purpose.
Internal organization independent of purpose.	Higher order organization defined by purpose.
Controlled by external policy.	Self-regulating and self-adaptive.
Programmed actions toward given outcome.	Regulation of steady state dynamics through change and governance of meta-system's self-adaptive and self-regulatory tendencies, through policy formation.
Feedback and general control by action amplification.	Goal-derived feedback.
Emphasis on feasibility (timeliness) of alternative action schedules.	Defines mechanistic system's operational characteristics.

These two models, or modalities, of planning must now be discussed.

8.

What do we mean when we talk of planning as a *mechanistic* model? We mean that there is an order or level of planning which results in plans that are closed systems, these are constructed to solve specific classes of problems in the light of given goals which have been conceived outside the plan's own system.

Here the idea of "closed" system must be understood in the sense of a cybernetic model (Ashby's "machine with input") which allows information to cross its boundaries, but is "closed with respect to entropy transfer." (1)

Such a plan is mechanistic because, like a machine, it is designed, programmed, instructed to serve a purpose on which its inner organization need not be dependent – the purpose is external to it as it is external to all artifacts made by men. Hence, the main and necessary condition that governs this type of planning is the existence of another higher level plan in which the goals are set. I shall call the mechanistic type and level of plan an *Operational Plan.* This is the kind of planning we best know how to do and we do the most often. Insofar as the present epoch is concerned, operational planning is the *orthodox* mode of planning.

Today the most generally applied type of orthodox planning corresponds to what I should like to term the "Order and Control Sub-model."

Planning, in terms of this sub-model, is directed mainly to the ordering of the space of a system of events; i.e., a particular or limited situation. Here, complexity is reduced by means of non-time dimensional arrangements called "programs." By "reduced," we should understand ordered into categories. This type of planning is a problem-solving device in which solutions mainly take the form of the reconfiguration of resource allocations. In this class of instances planning exists on the authority of external policies in which certain immediate goals are viewed as critical. Hence, the solutions tend to represent novel applications of already available technologies. Control is often affected by means of positive feedback – that is, by amplifying certain lines of action rather than adjusting them to the requirements of a temporal goal. This type of activity emphasizes *means* rather than ends. It is problem-solving rather than planning. Its main results are to insure continuity of non-integrated solutions that attain momentary stability through series of sub-optimizations. Here we have a good example of planning that is a closed system directed to the solution of specific problems in the light of goals that have been conceived and dictated from outside the planning system.

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(1) Ludwig von Bertalanffy, "General System Theory – A Critical Review" in *Modern System and Research for the Behavioral Scientist. Op. Cit.*

Orthodox planning also takes the form of two other variants, one of which could be called "Action Scheduling Sub-model"; the other, "Action Optimizating Sub-model".

In both instances planning is addressed to what is taken, a priori, to be the future states of different sectors of the meta-system. In this sense the sub-models are conceived in either of two modes: parallel and comparable *action schedules* toward a specifically definable situation; or, various *strategies* leading toward several envisioned situations.

In either case trade-off and cost-effectiveness analyses are made to find the best means to reach the given outcomes (i.e., forecasts). In the course of this attempt the main choices bear on the specific actions or on the strategies that are capable of linking the present to the expected situation. As these choices are made, the configuration of the forecast is altered to fit the criteria of optimality, which in the overwhelming majority of cases is "feasibility." Hence, this manner of planning concentrates on "how to get there" – wherever that may be – rather than on "where should we go?" In fact, it is the *how* consideration that ultimately dictates the shape of any acceptable, hence accepted, future.

When planning is grounded in the "action schedule" mode, there often arises the necessity of controlling the environment so that the forecast actions occur in the manner established by the plan. This leads to what might be called *authoritarian* planning.

If planning is cast in the "optimal strategy selection" mode, a greater flexibility is introduced, which leads to competition among various possible strategies. Generally speaking, the competition is reduced after a while to a problem of *time*. Therefore, in this instance a time compression phenomenon occurs which often leads to a high rate of change in the sector covered by the plan.

Again, such planning depends on goals that are established from outside the system of the plan – hence, once more the function of policy making and planning are seen to be separated. Valuation is applied to complex combinations of means while goals are determined in the light of current values to achieve sectoral and partial improvements in the ongoing situation.

Today, a great deal of orthodox planning is taking place in government departments, corporations, banks, foundations, the military establishment, charitable institutions, universities, research and development – in sum, in every nook and cranny of our bureaucratic set up. We plan decisions, we plan weapon-systems; we plan innovation; we plan organizations, we plan urban development; we plan some aspects of our economy and a great many more aspects of the economy of other countries, we plan for (that is, against) poverty; we plan slum clearance; we plan education, training, retraining, retreading (this is what one does to the "hard core" unemployables), manpower – the list is endless and obviously meaningless. We also plan "the future". Five-year plans are what we like most, ten-to-fifteen year plans are beginning to be in fashion; longer plans – twenty, thirty, fifty years are regarded the way five-year plans used to be regarded a decade ago – with a great deal of headshaking and shoulder-shrugging. And to tell the truth, we are not really planning for these long distances. What we do is to talk about what is going to happen in the year 2000 and how horrible it all is going to be.

Thus orthodox planning is growing at a tremendous pace. The reasons for this are many: there are psychological reasons, first among them being the fear aroused by the feeling that we have somehow lost control, there is the impetus to order complexity so as not to lose further control, but very importantly there is also the fact that thanks to advances in computer technology, it has become possible now to engage in some aspects of planning that eluded us a few years ago because we just weren't able to collect and handle all the information that is needed at certain levels of this work.

The role of the computer in all this is so central and so often misunderstood that it might not be out of place to say a few words about it (1).

Computers today can carry out the following operations:

– They can store very large quantities of information.

– They permit an almost infinite number of very high speed computations.

– Their combinatorial capabilities can be adapted both to large quantities of logical comparisons and to all manners of arithmetic operations.

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(1) For a brief but very good discussion of the role of computers in planning see, Britton Harris, "Computers and Urban Planning," *Socio-Economic Planning Sciences – An International Journal.* Vol. 1, pp.223-230 (1968). Pergamon Press. Printed in Great Britain.

– They allow one to aggregate large amounts of information at strategic points in a chain of reasoning, or to granulate that information and restructure it in different, more appropriate forms.

– They permit extremely lengthy sequences of information manipulation.

– Their selective search procedures are still weak but are being improved as are their combinatorial capabilities. Much further progress is expected in the development of their capability for retrieving information clusters in accordance with relevance criteria. This should greatly enhance our ability to address selectively particular problems or a particular part of a problem.

– They are able to provide real-time responses.

These capabilities now make possible a great number of planning operations that were formerly either too lengthy to do, or outright infeasible, or at any rate, too costly. Information is obviously the lifeblood of most planning, and although we have not yet made the necessary headway in defining precisely the information very large-scale planning requires, our current and growing ability to build and manage both general and special purpose data banks should improve our understanding of the kind of information we need for such planning.

Another important area that the computer opens up is the creation of real-time control systems. Control, as we have seen, refers to negative feedback. Thanks to real-time control systems, it is becoming possible to make stored operational data and environmental events react upon each other as the events occur. This is of central importance for gauging the responses of a great many agents to a great many happenings, and in the light of this knowledge to develop larger and more flexible (responsive) plans.

Perhaps the most exciting prospects the computer offers planning are in the area of simulation. Simulation is one way of making conditional predictions – i.e., testable hypotheses – about the behavior of a system under various artificially induced conditions. What the computer helps us do in simulation is to let us develop a theory and to test its consequences in terms of various dimensions – reasonableness, consistency, empirical and experiential validity, etc. Such a theory, together with its associated model, can also be used to simulate the consequences of changes in conditions and in policies, and thereby to provide us with a spectrum of outcomes that could be expected to occur in real life.

As can be seen from the above, the computer's potential role in all levels and types of planning appears to be extremely fruitful. It is perhaps unfortunate that we use it so extensively in what I have called orthodox planning, for the computer's very success and promise in this field seems to inhibit our ability to look farther. This inhibition is mainly attitudinal. It can even be seen in the outlooks of some of our most forward-looking thinkers in this field, and manifests itself mostly as a preoccupation with *feasibility* and *analysis.*

With feasibility predominant, our orthodox planning often brings about unforeseen and unwanted consequences because it is not conceived broadly enough and does not take into consideration the informal goal selection processes that go on in the community (or environment). This frequently results in the community feeling, and being, thwarted in its hopes and desires. Although many of the more progressive planners recognize the necessity for defining goals that reflect the true needs of the environment, over-emphasis on feasibility and highly analytic approaches tends to orient planning to the short-term and to the expedient. This, moreover, militates against the concern of those of us who have come to realize that planning must rest on a broader base and be more future-oriented if the shortcomings of both plans and planners, and the grievous lack of coordination amid the great profusion of sectoral plans are to be done away with or lessened. Aware as we are of these problems and of the need for serious and rapid solutions, we nevertheless incline to rely, probably too much, on computer technology and the advances it promises to remedy the situation. We do this despite our willingness to admit the need for deep and concommitant changes in social, political and individual outlooks, if any real progress is to be made.

Yet these slowly evolving views are important for they assess correctly the dangers of human fallibility and dissonant planning. Our orthodox planning practices do indeed create sectoralism and further fragment a society that is already threatened with deep division. We do need better, more representative ways of selecting goals and integrating them into our plans. But we must question whether this can be achieved solely as a result of improving our analytic techniques. Granted, that we live in a time favoring analysis almost above all else, yet it is also evident that what we need is an effort that frees us from this field of gravity with whose forces and attractions we are well acquainted, at home, and rather comfortably so. The challenge now is to break out into new conceptual and procedural areas. No one can say that the computer is not an invaluable aid to planning. However, what is most valuable in computer technology is precisely that it can free our imagination to search for new synergies and new solutions outside the range of orthodoxy. Unfortunately, when the computer is used merely to support the inadequacies of orthodox planning it tends further to entrench us in ways of doing things that have all too often proved themselves to be dead ends.

Therefore, what we must face up to is that within the presently conceived structure of the planning process it is not possible meaningfully to broaden it, to coordinate its activities or jurisdictions, to correct the fallibilities of human operators or to achieve that overall steady state dynamics in the environment which is the basic aim of planning. We cannot, from orthodox planning, deduce a planning system free of the shortcomings inherent in the very nature of orthodox planning. We are confronted here with a boundary problem that stringently governs the relationship between the system of planning and the total environment, and which goes beyond a merely logical difficulty. It is a profound problem of structure and of structural relationships.

The nature of this problem, as well as the insights it generates, will be discussed now in the course of our attempt to define higher order plans, those, namely, we have called "human action models".

9.

The governing characteristic of planning seen as a *model of human action* is that it defines and, therefore, contains within itself the goals toward which it is directed. It is a plan in which the outcome is invented or created as something new, rather than as a solution arrived at as a result of the manipulation of givens.

To understand the operations that occur at this level of planning – entropy control, higher orders of organization, regulation of steady state dynamics through change and the governance of the meta-system's self-adaptive and self-regulatory tendencies – it is best to start by trying to comprehend what we mean by "goal" and by concepts that are related to it.

To my knowledge, current literature – be it on planning or systems or behavioral sciences – does not provide any consistent definition of the word goal; nor does it provide a generally accepted distinction between goal, objective, purpose and end. Now, however, we have reached the very heart of the subject and for my own sake, as well as for that of the reader, I feel the need to set down some definitions which will harden and support my reasoning.

In the absence of technical sources that I could borrow from, I went back to the dictionary. My communion with Oxford Universal was, as usual, very refreshing, amusing and beneficent. I returned with the following insights: *Goal* can be used to refer to a particular and specific object that is taken to be the reason for a particular action. *Objective* can be made to refer to some intended result as the cause of action. *Purpose* must be understood to have two meanings: the intention to do something, and the function for which anything exists (1). (*End* was defined earlier in terms of its ethical connotations.)

I shall henceforth use these terms as interpreted above. It is interesting to note that none of these terms denotes particular durations. The differences between them are striking, nevertheless. Goal does suggest a greater specificity and a more particularized action pattern than the rest, objective is a quite general concept and does introduce a somewhat pointed causal relationship between envisioned results and action; purpose is still more general and refers to the intention to act or to the (given or natural) function that is fulfilled by the action.

Let us now review the notion of goal as it operates in the context of the action model I have called the "higher plan."

The first point to be made is that goals must be formed and that their *locus* is the individual brain. However, goals don't just get formed; they have to be formed in relation to values which, as we pointed out earlier, refer in the case of the individual to hierarchies of preferences. These individual preferences are, in turn, dictated and actually created by the social values to which a particular environment, seen as a particular culture, is historically committed. Again, such values are derived from larger sets of ends, whose nature defines the prevailing ethos – namely, the generally accepted notions of good and bad. Hence, when we say "Goals are formed," we are really talking about an extraordinarily complex process of intellection and multiple interlinked decisions that the individual experiences and makes. Actually, this process is somewhat simplified through institutionalization. Thanks to institutionalization the individual does not need to go all the way in thinking about the consequences of his acts. For instance, take religion. Religion is, among other things, an institution which defines what is good and what is bad and correlates all sorts of goals and actions with reference to these definitions: to give alms is good, to help the sick is good, to save money is good, to be productive is good, to covet your neighbor's wife is bad, to be slothful is bad, to disregard the teaching of the religious institution is bad, to have sexual relations without the goal of having children is bad, etc. Or, take science: to discover the truth that operates in nature is good, to go as far as one can in search of this truth is good, to find the ways and means of dominating or conquering nature by means of the truth is good, etc. Or, take an institution that is somewhat less universal than either religion or science – say, capitalism: to make money is good, to compete in the marketplace and win is good, to apply science to production is good, to be wealthy is good, to accumulate capital and increase one's wealth is good, to have possessions is good, to have more possessions is better, to have no possessions or to be poor is bad.

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(1) These are adapted definitions and not *verbatim*. However, in no case do they distort the fundamental meaning provided by the reference. For the original statements see *The Oxford Universal Dictionary*, Third Edition, Oxford: Clarendon Press, 1933.

In some ways it is often believed that good and bad, as they appear in these familiar examples, reflect what society will or will not sanction. Such a correspondence might exist during certain moments in history but it must not be taken for granted. The institutionalization of good and bad are, rather, the concrete expressions of certain beliefs concerning the functional effectiveness of a goal or an act with reference to environmental conditions. In other words, those goals and acts which are believed to be good are, by implication, also supposed to satisfy the organismic attributes of human social systems, i.e., reduce entropy, enhance organization, encourage a dynamic steady state, keep the whole environment in a viable balance that will benefit all the individuals in it. That this does not always turn out to be the case is a result of the dynamics of change. This dynamics, under certain conditions, is more rapid than is the ability of institutions to catch up. Thus a dissonance between environmental needs and the ability of institutions – and the value they generate – to satisfy those needs is created. Now, the prime motivator of institutional change, if our hypotheses are correct, is planning. But – and this question is critical – how can planning that is, itself, an expression of our value system, succeed in its aim of satisfying environmental needs by motivating the kind of change dynamics that will make planning functionally effective (i.e., reduce entropy and achieve higher levels of organization within the environment) if it is inhibited by the resistances, lags and inadequacies of the institutionalized value system? Is it even possible to form those goals which would satisfy the aim of planning out of the values generated by our current (and basically traditional) institutions?

The answer is obviously negative and the reasons for this will be discussed presently. One conclusion, however, can be immediately posited. Since, in the present state of our social organization, the individual forms his goals with reference to traditional (and often conflicting) values buttressed by institutional authority, he is under no compulsion to think out the far-ranging consequences of his acts.

These considerations raise certain important points regarding feedback. Feedback, as we have seen, regulates action and keeps it attuned to the goal. Given the goal, it has nothing further to do with values – except inasmuch as past experience, or acquired learning which happens to be the substance of feedback, is always conditioned by values. But feedback, nevertheless, controls action. In the most general case of negative feedback it corrects it and keeps it on the goal, through directive inhibition. Hence it might be viewed as the mechanism that various institutions use in keeping individual action consonant with the goals they espouse, or better, impose. But again, there are other kinds of feedback that must be recognized in planning. These are manipulative influences that any authority which has defined a value system might use: positive feedback which amplifies a weak commitment; intermittent monitoring of feedback which permits a check on how a great range of activities throughout the environment are doing in terms of stipulated goals and values, continuous monitoring of feedback which amounts to complete environmental control; proportional monitoring of feedback through which it is possible to develop a corrective control effort in proportion to the magnitude between the required and the actual value of the controlled quantity. Relay controls that order behavior in terms of *on* and *off*. Clearly, I am talking here of various types of behavior and activity regulation. They have all been applied at one time or another in the course of human experience, sometimes in political terms, sometimes in religious terms, or in economic terms, or in terms of everyday relationships among individuals, but always in the name of some generally accepted or generally imposed value tradition. Thus, feedback and feedback control obviously raise a great many important questions concerning the nature of planning and especially about the consequences that will result from various decisions and actions initiated in the course of planning.

These questions, along with the one we asked concerning goals and values, must be answered in ethical terms, namely, in those terms that I shall be discussing in the concluding part of this paper. Goals, values and feedback were brought into the discussion at this juncture because without them it would not have been possible to continue to explore meaningfully the functional aspects of the higher planning process.

What these probings have revealed up to now is that planning is an activity very close, if not identical, with what has been termed *teleological* behavior, namely, behavior in which "purpose [is] controlled by feed-back". (1)

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(1) Rosenblueth, Wiener, Bigelow, *Op. Cit.*

The idea of "teleology" has long been subjected to abuse and disuse. However, modern planning discourse would be impoverished without it; hence, I shall reintroduce it here in the sense in which it will be used.

> "Teleology has been interpreted in the past to imply purpose and the vague concept of a "final cause" has been often added. This concept of final causes has led to the opposition of teleology to determinism... It may be pointed out, however, that purposefulness... is quite independent of causality, initial or final. *Teleology has been discredited* chiefly because it was defined to *imply a cause subsequent in time to a given effect.* When this aspect of teleology was dismissed, however, the associated recognition of the importance of purpose was also unfortunately discarded. Since we consider purposefulness a concept necessary for the understanding of certain modes of behavior we suggest that *a teleological study is useful if it avoids problems of causality and concerns itself merely with an investigation of purpose."* (1)

I have quoted the above passage not only because I largely agree with its content but also because it makes an extremely important statement concerning a "cause subsequent in time to a given effect." The clarification of this point is essential to an understanding of what we mean by planning.

Past philosophical discourse, especially that branch of it called teleology, was predicated on the assumption (chiefly dictated by metaphysical considerations) that a "final" or ultimate cause was the motivating force behind all human goals and acts. This made such goals and acts the expression of a will above and beyond the will of man – a will, in fact, whose nature man could not fully comprehend.

This metempirical and transcendental will was identified first with the intent of God and later, during the period of vitalistic science, with the inner "purpose" of nature. As such, it resided beyond time. The past having already occurred, it had therefore to be registered as time spent, whereas the present was inevitably experienced as time (and duration) in being; consequently, the meaning of extra-temporal could be placed nowhere but in the future. So the future became the *locus* of final cause and thus always remained farther away in time than the effects of the actions it had inspired or forced.

This view in all its forms (of which there were many) has been discredited for a number of decades, but its influence remains, although attenuated, altered and wholly secularized. It is nevertheless an insidious influence. It can be detected, for instance, in the behavior of those who act as though they thought that the future had concrete existence and represented a configuration of events which was determined and could therefore be predicted. It has had visible impact on those who believe that goals and objectives do actually reside in the future and that one does in fact go toward them linearly, by means of sequential steps. It is obviously at work in the new scientific theology we call teilhardism (1). The major import of this influence is that it has fostered the erroneous belief that the future is a state beyond the present and linked to the present by time – and that human beings can actually have thoughts, form goals, establish objectives, that are in the future. It is this deep misunderstanding of the nature of time and causality – this almost unshakable commitment of our minds to some (any) type of determinism that has led modern science to reject teleology, together with all its other attributes. However, teleology as the "investigation of purpose" is and remains of unquestionable importance, not only for systems discourse but for social science as a whole and especially for planning. For in our model of planning, rational and purposeful action is warranted by goals and ends, and all such activity must be imagined as unfolding in relation to temporal referents that are dictated by the goal. Meanwhile, this unfolding can only be controlled by feedback if it is the stipulated goal that is to be satisfied and not some other unexpected outcome. Hence to make sense of our model and to understand its mechanism, we must look still more closely at the modes of action that are intrinsic to it.

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(1) Ibid. Emphasis mine.

What is it that we really mean when we say we must "invent" the future, or we must "construct" the future, or we must make planning "futures-creative."? (2) What we mean is "...*acting* in such a way as to make the future conform to some present vision of it. In a trivial and uninteresting sense, any action whatever 'creates the future.' If I raise my hand now, I have changed, in some way, what the future will be. However, 'creation' and, still more, 'invention' carry the connotation of conscious and purposive action (if not also of rational action), as well as that sort of conscious and purposive action which has the highest values set upon it, whatever these are taken to be." (3)

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(1) After the synthesis attempted by Father Teilhard de Chardin.

(2) The first of these expressions is from D. Gabor, *Inventing the Future* the second is from P. Massé, *Le Plan ou l'anti-hasard,* Paris, NRF Gallimard, Collection Idées, 1965 ; the third is mine "The idea of a 'Look-Out' Institution," Futuribles, Analyse and Previsions, Paris, 1966.

(3) Marx Wartofski, *Op. Cit.*

This future-defining, creative, inventive, purposeful, conscious and rational act is what, on other occasions, I have called an *anticipation.*[1] Anticipations represent the willing a specified future state of the system to result from action. To anticipate, in this sense, amounts operationally to constructing an anticipation model. Such a model is a "representation," which configures the present in relation to values and meanings that do not necessarily exist in it; at least, not in dominant forms. The introduction of, or the novel emphasis placed on, such values and meanings changes the entire event-structure with which one deals into a new potential configuration that is future precisely for being potential in nature. Yet this "future" exists in the present, for there is no formulated conception, no potentiality, no entity that can be conceived or be made to exist in any other time-space.

It is in this sense that we have teleological activity in planning, for the anticipations that are involved in it are *causative* in nature – they are *causative anticipations.*[2] The main attributes that pertain to such anticipations are normative, telic and kinetic. They are *normative* in that the purpose they represent is an abstraction of those factors we consider significant or valuable. They are *telic* in that significance or value can exist only with respect to some end in view which the whole planning model serves.[3] They are *kinetic* in that the recognition of a goal imbued with significance and value by a larger end is, or should be, causative of action. What this last point means is that a well thought-out purpose, supported by a reasoned image of future embedding conditions that are germane to it, generally triggers activity leading toward the satisfaction of the purpose and toward the realization of the envisioned conditions. Given ends to which it is possible to become committed, and given goals whose present value is evident, we tend to act in such ways as to turn these goals into reality. This notion deserves a short clarification because it is

(1) "I shall call anticipations such intellectively constructed models of possible futures so as to distinguish them... from predictions, forecasts, projections, etc." H. Ozbekhan, "The Idea of a 'Look-Out' Institution," *Op. Cit.*

(2) I do not wish, because of the alliteration that exists between "causative" and "causality," to be misunderstood and accused of reverting to the finalistic or deterministic teleologies of the past. My philosophical bias is well expressed in the following passage :

"According to this limited definition, teleology is not opposed to determinism, but to non-teleology. Both teleological and non-teleological systems are deterministic when the behavior considered belongs to the realm where determinism applies. The concept of teleology shares only one thing with the concept of causality : a time axis. But causality implies a one-way, relatively irreversible function relationship, whereas teleology is concerned with behavior, not with functional relationships." (Rosenblueth, Wiener, Bigelow, *Op. Cit.*)

(3) Marx Wartofski, *Op. Cit.*

rather difficult to grasp. First, causative anticipation should be distinguished from what is usually called "self-fulfilling prophecy." The latter occurrence is, generally speaking, an overreaction to certain types of feedback; it is best illustrated in the form of a lame syllogism. Two young boys are looking at each other. One of them says: "You're a filthy brute." The other hits him. With his nose bleeding the first one concludes, *sotto voce:* "I told you that you were a filthy brute."

At a higher level of discourse, the above story can stand as a good illustration of almost all orthodox planning, e.g., some forecasts indicate that, given current preferences, the population of Southern California will quadruple in the 1980's. This increase in population will, in some quite major ways, destroy the quality of life in that region, while if half of the projected increase could be deflected toward, say, Northern California, both regions might benefit. Nevertheless, the municipalities and local governments of the southern parts of the state are feverishly preparing for what is to come. New school districts are being contemplated, facilities are being designed, real estate is getting developed – in other words, everything is being done to make the forecast come true despite the knowledge that the result will be close to catastrophy.

The process I have termed causative anticipation would lead to a very different type of planning. Within the frame of the above example, it would cause the municipalities, local and state governments to develop those parts of Northern California toward which they want to deflect the oncoming trend – not only develop but design every possible incentive and attraction to induce settlement in the areas where it is known such settlement will be of benefit. Obviously, to engage in this kind of planning, both rationality and creativity are necessary – i.e., the ability on the one hand to make valuations among alternative purposes and outcomes and, on the other hand, to invent new norms that will permit new value judgments and give rise to a greater number of alternative outcomes to choose from. It is such choices that enable us to conceive of maneuvers in the space/time available, to set priorities, to define variously optimized modes of reach goals, etc.

The second point to keep in mind with regard to causative anticipation is that it leads to a kind of planning which, in addition to the normative and telic attributes I have just noted, is also *strategic* in character – this characteristic arises from its kinetic contents. In other words, such planning does not merely define aspirations, but also alternative ways and means of fulfilling these aspirations. It permits the envisioning of activities or behavior extended over time and mapped out in such a way that from every interim decision node there flow a number of consequences which must be judged in accordance with the norms and values that have initially permitted the new definitions of the ends, the objectives, and the goals of action.

It is thanks to these interconnections of norms and strategies that value extends its dominion: its guiding influence breaks through the boundaries of the pure mental act of aspiring and becomes translated into doing; namely, into concrete actions whose chains form those strategies among which choices, and trade-offs must be made, so that some optimality or some maximization inspired by a higher principle than just "getting there" can be achieved.

Thus by causative anticipation we automatically refer to a hierarchical, two-level plan which is normative as well as strategic. Hence to see planning as a total model comprising everything we have said hitherto, we must view it as a three-storied construct composed of operational, strategic, and normative levels. The entire structure is designed to generate processes that can produce different kinds of activities, depending on the will that governs the (or, any) single whole plan. And these activities must fulfil the function of changing a particular current organizational state of the environment into a higher one, as defined by human will. However, for this to happen, namely for the plan to fulfil its function – a fundamental problem must be overcome: the problem of *communicating* across boundaries. What I am talking about is, first, the internal boundaries of the plan, the ones which separate its three levels; secondly, the fact that they are the boundaries that differentiate the plan from the environment.[1]

Within the plan the three levels stand in a definite hierarchical relationship. Each represents a particular set of meanings and controls, that result in particular classes of action. It is clear therefore that we must, first, make assumptions about how these levels of action interconnect to form a functionally directed entity. Outside the plan is the environment, the meta-system. It has many constituent elements and laws (both natural and man-made) which feed and shape the events and hold them together in an always-changing organization we have termed "steady-state". What are the meanings, controls and activities generated by this environment which impinge upon the plan?

In both cases the notion of feedback, seen as controlling power, provides a clue – that is, feedback in conjunction with the notion of hierarchy. These two concepts permit the initial and important observation that each distinct level of

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(1) Whose current state, it should be noted, is the result of other ongoing plans.

action is controlled by feedback emanating from a different level of the hierarchy.

Moreover, this controlling feedback is, itself, a hierarchy of levels whose operations are of great interest. For each level of feedback depends for its particular manner of exercising control on the functionnal needs of the lower levels. On the other hand, the functional requirements of each level operate under the control of the next higher level.

Hence, the control structure of the plan is composed of two nodes: (1) control imposed by the laws that are specific to the internal, or constituent, elements of the plan; and (2) control that emanates from the laws that govern the meta-system surrounding and containing the plan.

This double flow of control must be understood not only in the sense of "corrective governance" (or power) of a subordinate activity by a higher one, but also as an *infusion of meaning* into the lower level, because the components of the lower levels are by definition mechanistic (or mechanical) and like the parts of a machine, they have no meaning in or by themselves.

These considerations can now be translated into the language of planning, as follows:

1. A plan is a complex dynamic system designed in the form of a controlling event-structure whose function is to effect in its environment, which is another complex dynamic system, the kind of organized change which current values define as "progress".
2. The structure of the plan can be visualized as having three hierarchically related levels:
   (a) an operational level at which the plan is mainly mechanistic in character
   (b) a higher, strategic, level at which the plan is kinetic in character
   (c) a still higher, normative, level at which the plan is telic in character.
3. All plans fulfil their functions under two general types of control:
   (a) controls that pertain specifically to each level of their structure
   (b) controls that emanate from the laws – both natural and human – that control the environment.
4. These controls work in the following way:
   (a) the normative plan, to fulfil its specific function, depends on the operations of all the levels below it. It delimits the operations of the strategic plan by imposing on it a boundary (the notion and function of "strategy") that makes it serve the norms which have been established through it.

(b) the strategic plan, to fulfil its specific function, relies on the mechanics of the operational plan and on the environmental inputs below it. It reduces the scope of the operational plan by imposing on it a boundary (the notion and function of "operations") that brings it into the service of the strategies defined as parts of it.

(c) the operational plan, to fulfil its specific function, needs inputs from the environment. It limits the scope of, while ascribing specific meaning to, these inputs by imposing boundaries upon them (e.g., selectivity in the light of criteria such as "feasibility," or limitations inherent in some discipline such as Operations Research, Systems Analysis, etc.) that cause them to be brought into the service of the operations defined for it.

5. In this way, control can be seen as transmitted downward to the most concrete level of environmental elements. This control, when imposed upon objects and events, is what results in the change of such objects and events – planned change. It follows that control and power of this kind must entail a *meaning* (the meaning which purpose embodies) that becomes transmitted through it from the normative level of the plan, through the strategic and down to the operational. (Hence a plan which is solely operational, or purely strategic, is actually devoid of meaning. It often appears to have meaning because there is always an implicit normative context that provides it.)

6. The fundamental problem in planning is to communicate an explicit meaning across the plan's inner levels, as well as across the boundaries that exist between the plan and the environment.

7. Nor can this problem be solved by arbitrarily ascribing meanings to operational plans and trying to translate these meanings upward into strategies and then into norms. The hierarchical organization of the structure of plans prevents this. The fundamental understandings to be derived from this fact are as follows:

   (a) the content and operations of normative plans *cannot* be deduced from the principles governing strategic plans;
   (b) the content and operations of strategic plans *cannot* be deduced from the principles governing operational plans;
   (c) the content and operations of operational plans *cannot* be deduced from the partial or sectoral requirements of the environment.

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8. Hence, we must conclude that, both in terms of control and in terms of meaning, it is the higher level in the plan's structure which elucidates the organization and information content of the lower levels – while the contrary is not true.

These structural and operational descriptions can now be used to complete our theoretical construct with an explanatory set of hypotheses about how it works in reality. This can be done most economically by reviewing and expanding the model in functional terms.

Planning, as I have conceived of it, is a future-directed decision continuum that can be visualized as a three-level structure and as a multi-phased process. The structure is made up of different typologies of decisions. The process consists of various functional relations that tie these decisions into a complex network of action flows and control mechanisms.

Within such a system three general classes of functions must be recognized and considered: (1) *administrative functions* that insure the system's internal coherence and govern, at the "operational" level, the implementation of the decisions taken at the two higher levels; (2) *goal-setting functions* which I shall view as corresponding to executive decision making at the "strategic" level of our model; (3) *norm-seeking functions* which are the core of "normative" planning and correspond to what usually goes under the name of policy making.

It is important to note the differences that exist between this particular scheme and what I have called orthodox planning. In the latter, two major types of functional relations are found. One is the administrative/operational, which is similar to what I am proposing. The second is a somewhat confused relation that is said to prevail between the allocational/strategic functions. We have seen earlier that I do not feel this particular relation to be either operationally meaningful or particularly helpful to our understanding of planning. While executive decision-making does play a strong role in allocating resources, this process can hardly be divorced from that of goal-setting. Hence I consider goal-setting as the heart of strategic planning. Orthodox practice, however, sees goal-setting as part not of planning but of policy making. In my scheme not only is goal-setting part of planning, it is intrinsic to the executive level and not to the policy level.

Moreover, I maintain that planning does have a policy-making phase which I have called normative planning. Here the core of my argument is that not only policies are part of a meaningful planning process, but that policy making does *not* consist of goal-setting – it consists of norm-seeking. So, as can be seen from this brief outline, the differences between the proposed scheme and orthodox planning are quite fundamental, except, perhaps, insofar as the administrative/operational functional relations are concerned.

I shall now attempt to elaborate these points by detailing the strategic and normative levels, while briefly noting some of the pathologies that often affect the administrative functions at the operational level. Following the order of discussion I have hitherto used, I shall start from the operational level and proceed upwards through the strategic to the normative. As will be seen in due course, this manner of organizing the discussion will permit the introduction of the environment into the reasoning – this often neglected aspect of planning is crucial. If developing the discussion in an unusual order makes it easier to bring the environment in, this alone is, in my view, sufficient excuse for proceeding upward instead of downward.

I will now deal briefly with administrative/operational functions, not with the intention of shedding new light on a subject that has been quite fully treated in the literature, but rather to remind the reader that what I have called a "planning system" is not simply a set of abstract concepts, complicated tables of figures, alternative projections of this or that trend of events toward this or that time horizon. Much more than these things, it is people. People who receive instructions or give them; people who meet in councils and committees; people who are called upon to make decisions in support of which little information is usually available; people who are baffled by their responsibilities and often uncertain as to both their private futures and the future of the function they are carrying out. In the ordinary course of events these people relate to the planning system, not as to a discipline or an intellectual challenge with deep philosophical or social implications; they relate to it as to an institution in which they play roles that have been spelled out in their job descriptions. These roles turn them into *personae* and it is as *personae* that they interact administratively, that is, as participants in an extraordinarily old, intricate, ritualistic dance. In modern social theory the whole thing is called *institutional behavior.*

When we perceive our planning construct with this further dimension tacked on to it, it becomes quite clear that we have here an institutional entity that is related to its environment in some deep symbiotic way. And the quality of this symbiosis is rather curious. If the premises of this essay's basic argument are granted, we cannot but proceed from the notion that the single most obvious *raison d'être* of any planning is to change the environment in a manner that is smooth, timely and orderly and thus to achieve a dynamic social evolution consonant with our ideas of organized progress. The most powerful agent of social progress, however, is institutional change – and change is one experience that institutions are not designed to undergo gracefully. This is a particularly painful situation for any institution concerned with planning, for it – like any other member of its species – literally lives off the environment (consuming money, people, resources, materials, etc.). To change the environment often means a different allocation of these same resources – a difference that might spell shifts, reductions, abolitions and abrogations, all of which reconfigure the symbiotic relationship noted above. To prevent the frequent occurrence of these dire circumstances, institutions, including planning ones, tend to strengthen their administrative characteristics. By "administrative" I mean that aspect of institutional behavior which ministers to the continuity and stability of existing functional relations between roles. Through such ministrations all present configurations are shielded from change by the very institution which is supposed to be the agent of change. That is why I have earlier qualified administrative functions at the operational level of planning as representing something of a "pathology."

This state of affairs is greatly encouraged at present by the divorce which has been pronounced as existing (institutionally, that is) between policy making and planning. Contemporary orthodoxy requires that the goals which will inspire and guide the operation of plans be set at hierarchical levels far above the organizations where plans are made. Thus, in practical terms, new goals are set outside the planning system on the assumption that system must be capable of implementing any solution such goals require or represent. This assumption generally leads to two types of result: (1) the planners attempt to protect their administrative continuity by interpreting all new goals in terms of the initial goals included in their organization's original charter. (e.g., a planning entity first set up to solve the transportation problem through the design of better freeways and parkways cannot interpret any new goals demanded by a changing transportation environment or policy, except in terms that are related to freeways and parkways. Any wholly new solution is obviously a clear and imminent threat to the entity's administrative structure, not least for being almost unfailingly beyond the competence of its current personnel. This behavior can only lead, in most cases, either to the ignoring or distortion of the new goals. (2) Knowing this to be a fact of life, the policy-making authority creates new planning entities and institutionalizes them, every time it establishes new goals. This necessarily results in the uneconomical proliferation of administrative organs competing for the same resources, as well as in competing plans. The problem soon becomes one of outright, almost instinctual, conflict among entrenched interest groups. (Fascinating examples of this kind of outlook-dispersion, activity-fragmentation and resultant power plays are found in extraordinary quantities in the Johnson Administration's approach to the highly complex issues that used to go under the name of the Great Society Programs.)

And now let us proceed to consider the functions that are found at the strategic level. I have previously defined strategic activities as centered around the function of *goal-setting*. This, in our model, involves (1) the derivation of specific planning goals from objectives established at the higher, policy-making level of normative planning; (2) the choosing of an optimum group of interrelated goals – this is where the "setting" comes in; (3) clarification of the trade-offs – i.e., allocation of resources and value maximization – inhering to the various strategies that could be followed to convert the goal(s) from a future idea into a present reality.

This is not the place to analyze all these decision sets and cognate activities in detail; however, some general remarks can be made about the function as a whole.

First, let me suggest that the goal-setting function is a strategic function and not a policy-making one. (Policy making as we shall see later consists of seeking norms.) Secondly, goal-setting is part of what in administrative theory is sometimes called "executive decision making". In other words, goal-setting is undertaken in the execution of policy rather than in its formulation (orthodox statements to the contrary notwithstanding). Thirdly, goal-setting is in some very deep sense "regulative" in character. It is at the level of strategic decisions that the problem of the availability of resources must be faced and ways invented to devise strategies that are so combined as to succeed in maximizing the results – or, as they often say, the "values" – to be derived from any strategic program(s) one adopts. With reference to these constraints I have, on other occasions, defined strategic planning as the determination of what *can* be done to satisfy a given policy or set of policies.

All this adds up to being regulative because to reconfigure a system of resources always represents a cost whether this be in terms of money, of efficiency, of effort, of time, or – and this is probably the most important cost – of opportunities, namely, of whatever alternative uses could have been made of the same resources had different strategies been adopted. Hence this subtle cost factor in executive decisions tends always to restrict the plan's strategic alternative – the goals that could (or can) be set to attain the aims of particular policies – by the very momentum that regulative influences impose on the decision makers. In this shift of emphasis we notice a very interesting phenomenon: the slow, silent and almost invisible encroachment by administrative outlooks of the executive area resulting in the patient erosion of what "can" be done by what "will" be done – which, in the natural course of institutional activity, is hard to distinguish from what "is being done". Only a very strong executive and a very powerful strategic concept can resist this trend. And, although strong executives (in the shape of persons capable of imposing change on the system) are encountered from time to time, strong strategic concepts derive their consistent power from policies that are deeply rooted in reality. The problem of forming such policies brings us to the discussion of the highest level of planning, that is, of normative planning.

At the "normative" level, policy-making functions take the form of *norm-seeking,* followed, obviously, by the definition and selection of appropriate norms.

Before I discuss this most important set of functions, let me repeat briefly something I have already noted: in the practice as currently conceived, policy formation and formulation are viewed as decisions which precede and transcend any planning. This creates a dangerous functional distortion by allowing policy making to be seen as the "political" activity that defines objectives (and goals – for the two are often confused), while planning is viewed, at least by implication, as consisting of "administrative" work undertaken to regulate the implementation of given policies. This marring feature of orthodox planning has at least three strangely impoverishing consequences: (1) It creates a gulf between those who must sense the evolving needs and emerging problems of the environment in order to create policies that meet the former and solve the latter, and those who must develop strategies and allocate resources in order to make such policies or solutions actionable; (2) In everyday life such a gulf has to be bridged for otherwise there would be no meaningful communication between the levels. This requirement then causes the policy maker, who should mainly be concerned with change inspired by what *ought* to be done, to become too concerned and influenced by the problems of the executive beneath him, who keeps reducing all issues to what *he* thinks *can* be done – this is generally called being "practical" or "having one's feet on the ground," etc. (3) This tendency, in turn, results in the upward creeping of administrative and regulatory outlooks, similar to what we have seen happening between the strategic and operational levels. Thus policy making also becomes tinged with administration, and planning as a whole ends up as the regulation of the present situation. It is actually converted into an instrument for extending the present, that is, for administering what I have earlier called the "logical future".

To counteract the deadening impact of administrative domination, it seems necessary to see planning not as the handmaiden of policy making but as the larger framework of decision and action processes of which policy making itself – that is, policy making in the form of norm-seeking – is an intrinsic phase. I shall now attempt to show both how and why such a hypothesis has operational validity.

Norms were defined earlier as rules or standards which, in relation to specific values (or general ends), permit us to determine the legitimate value content of alternative valuations. In the same vein we also noted that "value judgments" were statements whose purpose is to define, select and test norms as to their applicability, validity and legitimacy with reference to specific valuations or alternative lines of action. These propositions make it clear that in my understanding policy making within the context of normative planning is primarily the exercise of value judgments to determine what, in the face of a particular situation, "ought" to be done. Or, in other words, what norms ought to be selected or invented to develop policies (solutions) that are consonant with both a given value outlook and the problematic situation one is confronted with.

Such judgments are extremely difficult to make on two counts: (1) policy makers don't necessarily have a deeper perception of the problematic situation than most other people – their information about the environment is often more voluminous but not always better developed or organized than information that is generally available; (2) policy makers, because of the type of individuals traditionally selected as well as current methods of selection, are quite inept at normative reasoning – this is another way of saying that their training is, by force of circumstances, mainly administrative and in rarer cases strategic, at best; and which, for lack of any other training, they take their acquired skills "upstairs," whenever they are promoted.

None of this is actually the policy maker's fault. After all, those who to-day are in positions where policy-making skills and normative reasoning count were for the most part educated in an atmosphere that prized ethical neutrality and in the belief that all operationally valid decisions are made independent of value considerations and according to the dictates and measurements of the hard sciences. Therefore, we have few, if any, live examples of policy making as a function of normative planning. This being the case, I shall outline the process in explicatory terms.

To make my task easier, I shall begin by ruthlessly pruning our current value system, thereby simplifying it down to its absolute essentials. When this is done only two abstract values – one at each end of the scale – remain to be dealt with: "the good" and "the bad". Throughout history (and by history I shall continue to mean the history of what is generally referred to as Western peoples'), the concepts of good and bad have been used to qualify many different actions, thoughts, outcomes, policies. These valuations, however, can also be seen to have changed according to circumstances.

A prime inference to be drawn from these inconsistencies or discontinuities is that our notions of the good and bad, our most fundamental values, are a function of situations, namely, of the congruence of environmental events and of how we choose to look at and to react toward these events. The reasons why we look at events are numerous. But, once again, if we hack at the undergrowth of our confused emotions, responses, misunderstandings and fears, and if we clear away the inflammable brush of inherited prejudices, conditioned distortions and irrelevant static along our channels of information, we find that we look at things, at humans, at occurrences, for two main reasons: to learn about their nature and to make use of knowledge thus gained.

To acquire knowledge about natures and to use this knowledge are therefore the two deepest modes of relating to our surroundings that we know of, and it is within these modes that we must search for the stable norms or standards which on the surface of a situation appear as valuations that are changeful and inconsistent.

A first, clearly basic difference becomes immediately visible when an attempt is made to distinguish between the normative content of these two modes of perceiving occurrences – namely, of looking at facts. This difference is that, if anything is looked at with the aim of gaining knowledge about its nature, issues concerning the good or the bad do not really enter into consideration. When I say they do not really enter into consideration I mean that they are not helpful in the acquisition of the knowledge we are seeking. They are irrelevant to our motive and may even be a hindrance to the attainment of our aim. The look we take at the nature of things is ultimately an observation, and natures – not excluding the nature of man – are best observed directly, with no judgment interfering.

The problem changes entirely if the motivation for looking at, studying, considering, anything is "use". The initial comment to be made here is that in the very same way that everything under the sun can be looked at with the aim of understanding its nature, so can anything and everything under the sun be looked at with a view toward understanding the use one can make of it – I cannot think of any exceptions. However, the difference between the two modes of looking is that, whereas in the earlier instance objectivity requires observation which is as free from valuation as possible, in the second instance that same objectivity cannot even become crystallized except when it takes the form of a valuation.

Use as the basis of knowledge is the central core of action: it is the central core of political action, of social action, of economic, military, technological, moral, ethical action. It is, therefore, the central core of planning as we have defined it. In order to make decisions in planning we have to deal with facts, pure, complex facts of great specificity as well as of intricate interrelationships. To deal with such facts, we must not only be in possession of knowledge about their nature but of how we can use them in order to solve our situation's problems and achieve progress. This latter aspect of the issue – by far the larger, the more difficult and the more obscure aspect – imposes on us the necessity to make value judgments, namely, to make judgments that will allow us to define the norms which must govern the decisions required by planning. It is a peculiarity of these value judgments that they involve not the mere observation of facts, but what I should call *prescriptive-perceptions* – I mean by this a manner of apprehending a fact which even at its very first, perceptive, stage is not free from a judgment about it. This is another way of saying that in these cases comprehension itself appears to be a function of valuation, namely, of our ability to classify what we observe as "good" or as "bad" with reference to its use. The only valid question one can raise about such prescriptive-perceptions is whether they possess universality. In turn, this question can be solved only by a deep understanding and analysis of the *facts* – not facts *in vacuo* or facts *in vitro,* but *facts in context.* And the larger the context, the greater is the validity of the prescriptive-perception. When I say "large" I have in mind the full space of a fact's reverberations in terms of its present as well as its future consequences.

What I have argued up to this point has been merely that no fact approached with a view toward action, namely, with a view to using the knowledge gained from observing it, can be intelligently apprehended, understood or interpreted, except in value terms: in terms of whether it is good or bad for man, for the community, for society, for the present and for the future. If these thoughts are valid, then it follows that normative planning consists of developing prescriptions derived from the investigation of facts and set forth to serve as guidelines for action. The question which needs to be answered now is: how can we establish such norms of guidelines in terms of the universality they require? And again, how can the context of the facts we look at be enlarged so that the prescriptions are legitimate? The answer must obviously be sought and found outside the plan; in the situation that shapes the environment, in the configuration of events whose structure is problematic and therefore bad (in value terms), and which through planning we must change into another configuration whose structure is deemed to be good.

To arrive at such an answer, we must (1) consider the most general norms that we employ almost unthinkingly in our daily valuations, these being the norms which within the confines of our particular culture can be said to possess universality; (2) look at our environment with the aim of determining if today these norms allow us to make valuations that are legitimate or valid; (3) reason out whether the present situation, i.e. the context of current facts, requires new norms and what these might be.

First, then, let me review briefly the most general governing norms we automatically and almost unconsciously use in making valuations. As I have already suggested, the moral experience of Western mankind has evolved along two main lines. One is the humanistic tradition, rooted in what I should like to call the culture of "The Book", which defines Judaic, Christian, and Islamic ethos. Even if we choose to remember its disruptive religious basis and the heartbreaking events that make up its history, the fact nevertheless remains that this tradition is primarily inspired by the valuing of an increasingly individuated society. The growing scope of this idea is variously but unerringly asserted, first in the notion of the "chosen people", then in that of the "community of believers" and finally in that of "universal brotherhood".

There seems to be no single word to express the attitude or outlook or need or aspiration that underlies and gives actionable meaning to this value that focuses on social concourse, unless it be an expanded notion of *love* taken as the norm.

It is obvious that love in this sense does not solely refer to the gravitational emotion which causes men and women to be attracted to each other and bonded together; nor is it solely an instance of individual abnegation and surrender to other-worldly pursuits that the metaphysics of Christianity in its earlier stages brought so furiously into fashion. Love as a norm supporting and defining man's assumption of goodness in social concourse underlies rather the need to recognize attributes of singular worth in the human state, to value and respect that state as something which, while belonging to the natural order, is yet apart, different, and unique.

The second tradition which, today, provides us with norms is the scientific. Having already discussed this at some length, all I need say is that in it the governing value is truth insofar as this is capable of being observed and the norm which underlies and qualifies this value is *objectivity*. We have noted earlier, however, that the scientific tradition has had an offspring of vast implications in technology. The normative difference between science and technology is probably found in the fact that, whereas science is concerned with knowledge about the nature of the object, technology is concerned with the combination and conversion of natural objects into things that are useful. The underlying norm of technology, therefore, is not objectivity but *utility*.

Thus, it would seem correct to say that at the present time Western humanity decides and acts mainly with reference to values that rest on three general and traditional norms: *love* as social bond, *objectivity* and *utility*. Let us now look at the situation currently prevailing in the environment to determine whether in that context these norms are necessary or sufficient for planning.

The dimensions and structure of the situation in which we live were suggested in the list of problems which I provided in an earlier section and qualified as being "continuous" and "critical". The feeling one gets from that particular list, or any other compiled for similar purposes, is not necessarily that the nature or composition of the ills that beset humanity have become radically different. Many of the problems we experience today have been with us for a long time, and those of recent vintage do not seem insurmountable, of themselves. The feature that is wholly new in the problematic aspects of our situation is rather a frightening growth in the size of the issues and a tendency toward congealment whose dynamics appears to be irreversible. The congruence of events appears suddenly possessed of a direction and a total meaning which emphasizes the insufficiency of all the proposed solutions increasingly and reveals rigidities that are not stable or set, that do not confine the problems but enlarge them, while also deepening them. This suggests that our situation has an inner momentum we are unable fully to comprehend; or, rather, that we are trying to cope with it by means of concepts and languages that were never meant to penetrate complexities of this kind; or, again, that we are trying to contain it with institutions which were never intended for such use. Therefore, even to be able to talk meaningfully about these problems (or, is it a single problem that is facing us?) we need first to develop a conceptual approach and a language we can use, which correspond better than what we now have to the essence of the situation.

As we attempt to develop such an approach and language, a first point comes to our notice: the components of the situation are formed by a multiplicity of complex occurrences that are both natural and social in character, involving as they do numberless interactions that tie habitat and man-to-man concourse into events we do not know how to sort out in terms of any traditional system of causality. I say this because the causal logic with which we are most comfortable is the deterministic one, which we have greatly refined while developing our increasingly sophisticated scientific method. But the socio-environmental situation I am talking about far transcends in complexity any situation that could be accommodated within the type of deterministic arrangement one is able to visualize in the hard sciences. That is the reason why we gain the impression, when we look at our environment today, that in its unexpectedly intricate patterns there is a haphazardness, an indeterminancy, a randomness that appears almost capricious. Whenever we try to simplify our perception of this situation in order to find in it a meaning that can be made to fit into deterministic terms we find ourselves reduced to the almost meaningless clarities of social engineering. These, unfortunately, are clarities which, far from clarifying, distort reality through simplification and, if anything, increase our impotence in dealing with the confusions that are before us.

Yet we must find a lesson in the fact that our traditional notions of deterministic causality fail to suggest a solution to the dilemma, and this lesson must lead to our becoming reconciled to the fact that social causation, rather than being indeterminate or random or devoid of meaningful patterns, follows a different, non-linear, multi-valued kind of determinancy. For surely it would be untenable to argue that the events which surround us occur by spontaneous generation. That would be to argue that the exercise of human will, decision and action is not causative of results. On the contrary, what needs to be argued is that human will, decision and action are perhaps the strongest embodiments of causality; that it is they which generate the situation we find problematical. This being the case, it must be that the causal relationships we are trying to figure out are difficult to grasp because the consequence-space of every act has widened to the point where it resonates throughout the entire system, the meta-system, the earth, the globe, the world — you choose.

When actions resonate right up to the boundaries of the system (and let us not forget that these boundaries are temporal as well as spatial) we must begin to view causality in a number of new ways: as flowing from multiple sources in the form of different types of action that add up nevertheless to total and complex consequences of vast proportions, or to discontinuities, or to conflicts.

In the analysis of our situation the fruitful point, then, is not necessarily to try to establish one-to-one relationships between acts and outcomes. It is to think in terms of the dynamics, momenta and equilibria created by an almost infinite number of decisions and actions in constant flux. The fruitful attempt, in other words, is to view all activity and relationships that occur (*intra* as well as *inter*) in the natural and social realms as forming one single, system-wide *ecological* reality.

This undoubtedly enlarges the meaning of ecology beyond its classic frontiers, but it does not distort that meaning. Let us, therefore, say that in planning discourse ecology is the most general concept, namely, a concept which finds legitimate application in every aspect of the systems with which plans are concerned. The term, as one scarcely needs to elaborate, is borrowed from biological science where it refers to the study of the equilibria and the dynamics of "populations" of living entities within given or natural habitats. To make it meaningful in planning, it is sufficient to extend the idea of population and generalize it into a notion akin to that of "universe" in statistics so that every aspect of the environments we have previously named – life/nature, social/human, thing/technology – can be subsumed under specifiable ecological facts, while the totality of these facts is viewed as a single *ecosystem.*

By extending the concept in this way we see all the dimensions of the reality that is emerging in our environment. For every dimension of contemporary experience is a definable population of facts and concepts: biological, physiological, physical, psychological, ethical, religious, technological, economic, political, national, international, communal, attitudinal, intellectual, institutional, pathological... the full list is no doubt finite but very long indeed. Thus, with reference to an ecologically conceived human reality it should be possible to deal with phenomena relevant to planning in terms of such conceptual descriptors as space/time, quantity/quality, flows, levels, dynamics, and equilibria. Moreover, thanks to ecological approaches, the full logic of systems can be accommodated into planning discourse without any of the distortions, and without the fragmentation of reality that is usually forced upon our reasoning by the structure of our languages. Further, the ecosystem equation provides us with relatively simple tool-concepts which happen to be highly pertinent to any planning theory: these are relations that define mutual determination, complementarity and competitiveness.

When these relations are placed in the frame of reference of our continuous critical problems we begin to understand that the issues which confront us affect the interfaces of the various components of our ecology and that the solutions we envision must be designed for such interfaces. This suggests that we must aim at implementing integrative solutions which organize the ecosystem at a higher level. Such higher order organization is what I shall call *ecological balance.* And it is this concept that I propose as a new and fundamental norm to guide policy making in our current high-entropy situation.

Any elaboration of the operational significance of this norm must first note that it does not displace or eliminate the traditional ones, but that it does introduce a new configuration into the normative scheme and thereby redefines them and *changes their value content.* These changes are best understood when reviewed in a somewhat historical perspective.

Love, as the principle of the phenomenon of social bonding, is probably the most complex of our traditional norms. Underneath the extraordinary profusion of detail a main line of events appears however, in which disparate steps in the individuation of persons and groups (leading from hominization to socialization) bring us, after some dead-ends and many detours, to that unit we call "nation-state". This latter could be taken as an institutional manifestation of the tribal-biblical injunction "love thy neighbor". In our times we more or less go so far as to accept as "neighbor" the other citizens of the nation-state to which we belong, but this is where it all stops. The next step that Father Teilhard de Chardin called the "planetization" of man has not yet been taken. Policies that govern relationships among nation-states continue to exude self-interest as their guiding emotion and principle. The stage of planetary bonding appears a long way off. It could, probably, be argued that in recent decades, since the end of World War II to be exact, some progress in these matters was actually reflected in a few major policies. The formation of the United Nations comes to mind as an instance; the Marshall Plan, in its initially proposed form, is another example; Point Four and similar technical aid programs emanating not only from the United States but from all technologically advanced countries, could also be cited. The abolition of the colonial system, the European Economic Community, the Peace Corps and the numerous functional, regional, economic and political groupings... many attempts have no doubt been made and will be made. Yet, the lesson to be learned from all this remains obscure for one finds no new invention, no original concept of approach at work in any of it. The larger ecological reality remains unrecognized at the level of world politics. What we witness appears to be an endeavor to extend various fragmented self-interest spaces, through a search of common interests. Maybe this represents a slow, glacially slow, and seemingly unconscious, attempt to break the hold that the idea of nation-state has taken; it has full dominance now over our minds, over our ability to conceive of other new ways of establishing larger and wider social bonds. For the moment, no evolutionary leap seems to be in the making in this field. Nevertheless, we are forced to conclude that the introduction of ecological balance into our normative scheme requires that the notion of social bonding be viewed as transcending the idea of nation and extending to the planet as a whole.

The changes in the value content of objectivity and utility should be taken in relation to each other. This is because in recent times science and technology have become highly interactive – to the point that nowadays we often talk of "techno-scientific" work. As I have noted in Part I of this paper, there are important problems created by this intimacy. Science as the theory of nature has a seemingly solid intellectual foundation. It strives for the correct understanding of certain classes of facts, with the aim of satisfying a value called truth. In this pursuit it has developed decision-making procedures called scientific and a basic norm – objectivity – which influences the work, outlook and personality of the practitioner of science. These elements appear to meld successfully in the creation of knowledge pertaining to a number of fields. The fact that much of this knowledge can be used in other fields and thus satisfy the norm of utility, which governs technological endeavor, merely complicates the scientist's personal value system. Because in these neighboring regions truth, as he understands and defines it, is not necessarily a prime value nor objectivity a dominant norm. Hence, when the scientist is asked to apply his special cast of mind to the solution of problems in other fields – that is, in fields where judgments about use predominate – it is never a foregone conclusion that a highly successful tranfer of talent has been made. In fact, because scientific training is so rigid and creates such deep attitudinal imprints, quite the contrary is often the case. Insofar as the norm objectivity is concerned, therefore, one must conclude that its revaluation in terms of ecological balance calls for science to become divorced once again from areas that require judgments regarding use, and return to the generation of knowledge concerning the true nature of things.

Utility, hence technology, on the other hand, presents a completely different picture and leads to very different conclusions. Here, we are basically talking of skill in the use of knowledge. In this skill we are unsurpassed and so engrossed with our own cleverness that we have sacrificed almost everything else to sustain it. We have built our whole world, all our systems – political, economic, social, institutional – around this dominant ability. Now, like an addiction, it has us in its grip. It has insinuated itself into our social policies, it has subverted science, it is reshaping individual life. It will not let go. But we have one thing left that we can do unless we despair of reason as the instrument of human will. We can, as an act of conscious will, ascribe new values to utility, and redefine technology, as an agent of policy – rather than looking at it as its main source. For, on rational premises, it does seem that thanks to our technological know-how, we could solve almost every one of the continuous and critical problems we have listed. Thus, *technologically speaking,* we have the capacity to feed, shelter, and clothe adequately every single inhabitant of this planet; we have the power to offer medical care to every human being on this planet; we have the knowledge to offer almost any level of education that we may think is needed, to every individual who may need it; we have the power to establish international controls that would abolish wars of any kind; we have the power to organize individual participation in political decisions concerning every issue in which such participation is beneficial. If poverty is an economic phenomenon, we have the power of abolishing it on economic terms. If social order is a law enforcement problem, we have the power to bring it about in terms of heightened policy efficiency. If our urban problems are problems of the physical reconception of cities, we can build or rebuild any city on the face of the earth. We have the power to do all this in technological terms. It is a pity that none of these statements is actually true because human destiny cannot be accommodated into the technological dimension alone. I believe that reality being what it is, even if we did everything I have just said we could do technologically, we would still end up with other, larger, more virulent problems because technologically we cannot define our future in a form that is wholly honest and complete. Yes, it is regrettable that today almost world-wide hunger and malnutrition cannot be eliminated simply by growing more food; that poverty cannot be eradicated by providing more welfare; that the problems of cities are not problems of cities; that health is not a medical problem; that law enforcement is not a police problem. As a result of things not being what their name says they are, it is in fact impossible to deal with them in terms of the parallel, one-by-one, linear approaches that technology offers. The problem we have to deal with is ultimately one of total redefinition based on the assumption that man has attained power, both over himself and over his environment and that "himself" plus "environment" formulate a new reality whose nature is an ecosystem, whose space is the whole earth, and whose value generating norm is "balance" — ecological balance.

In the light of this norm love as social bond can no longer provide a rationale for the world-fragmenting entity called the nation-state; it makes sense only if it provides the rationale of the planetized society. In the light of this norm objectivity in the scientific pursuit of truth must revert to its earlier vision of knowledge as an end in itself. In the light of this norm utility must again be subordinated to the other norms so that it loses its no longer warranted primacy, and technology can once more be put to good use within an overall view of the world seen as an ecosystem.

What policies are we then to derive from the form of ecological balance? To me, it appears that there are three basic points from which many lines of policy derive, and to which we must devote a great deal of thought. One is that today the relationship of man and environment, namely, man and nature, has changed. We are no longer fighting to squeeze a meager living out of whatever nature can yield. We no longer need to overcome our surroundings or conquer them. Nor are we separate from it; we are a dominant but working element within its overall scheme. This is what ecosystem means. The translation of this understanding into policies will redefine our old relationship, changing it from exploitation to nurturing (nurturing ourselves and it as one entity). For this, many ideas have been advanced: interlinking social, agricultural, industrial activities into regenerative complexes; recycling of raw materials within the system; development of self-feeding energy sources; etc.

A second line of policy derives from understanding ecological interaction; this means realizing that what we do and what we decide in one particular place will increasingly reverberate throughout the whole system. Simple though this fact is, it has vast implications for policy making. For instance: our inability to develop system-wide institutions that control population growth is clearly no longer a local or even a regional issue. Over-population in Latin America, or Africa, or India, or China is not a Latin American, African, Indian or Chinese problem; it is a world-wide problem, with consequences everywhere. Similarly, our manner of allocating and distributing resources, namely, the whole economy of the world, is something which requires entirely new policy ideas, because once again any imbalance in one locality will have large consequences throughout the system. What I am trying to say is that we must seriously put to question our accepted notions about the operation of markets, of the relationship between income, work and production, of the concepts of means of exchange and purchasing power on which our economic system (but especially our system of distribution) is built. We must think through and develop all the needed enforcing institutions that will implement adjustments and readjustments that are required to bring the entire ecology of the world into balance.

In this particular area one fundamental policy consideration becomes the setting up of what, on another occasion, I have called "look-out institutions". Such institutions must be equipped with every interdisciplinary talent that is needed to sense emerging (or future) ecological imbalances and to formulate and recommend policies to put aright any impending dissonance.

Finally, the notion of ecological balance should, once and for all, be capable of defining human responsibility in the causation of events and the formation of values. Until quite recently, we have been only too glad to assign this responsability to some exogenous power which we have often called God, and sometimes viewed as the hidden purpose of Nature. But, practically speaking, an ecosystem has no *outside*. Consequently, there is no way of viewing our own destiny except as what we, human beings, are able to do within and as part of *our* system. This fact should finally convince us that the responsibility has come to rest fully and squarely upon our shoulders, for there are no other shoulders on which it can rest. If we are finally convinced of this, our conviction should help us greatly to change our values – discard the obsolete, invent new ones and get on with the job of embedding the latter into our institutions.

In terms, then, of the planning construct we have been attempting to build we must conclude that the emergence of human reality as an ecosystem, which provides its dynamics to our situation, is a most important event and it is in the concept of balance, at the heart of that concept, that any planning at the normative level must find its guiding principles.

IV. TENTATIVE CONCLUSIONS

1.

A few comments should suffice now to bring these notes to a close.

No full synthesis, testing or evaluation of either our assumptions or our hypotheses will be attempted at this point. To do this would amount to actually developing the substantive theory itself and would therefore transcend my original intention in bringing these notes together. That intention, it will be remembered, was to propose a number of new approaches that might suggest the kind of theoretical work which is needed in the field of planning and is perhaps overdue. It should also be remembered that my original intention was to develop approaches leading to a *general* theory. This will allow me to organize the descriptive conclusions we have so far reached around a minimum number of statements about *planning, environment, purpose* and *plan.* Thus:

- "Planning" can be defined in its greatest generality as a future-directed decision process.
  - The fundamental characteristic of this process is that it is conscious and rational.
  - It represents acting on some object, defined as *environment.* Such action is undertaken for the *purpose* of effecting changes in the environment.

  - Planning, therefore, can be said to include the following: (1) perception of the environment; (2) definition of the purpose of the changes one wishes to effect in the environment; (3) design of the acts whereby the environment will be altered.

- "Environment" is a dynamic and complex ecosystem whose spatial and temporal characteristics are important for planning.
  - Any given moment in this ecosystem represents a *situation,* namely, a particular conjuncture of events having a specific configuration as well as a particular dynamic.
  - It is by affecting such situations that people change their environment.

- "Purpose" is defined as the intent that is intrinsic to planning action and gives it direction,
  - In planning the main purpose of action is to create controlled change in the environment.
  - The reason for wanting change in the environment is that complex dynamic situations tend toward increasing degrees of de-organization (ecological imbalance) unless higher order organizing activities are introduced.
  - Therefore, the purpose of affecting that situation through planning is either to solve the problems that inhere to the situation, or to improve the situation, or to establish a general control and dynamic over the environment so as to obtain organized progress within it.
  - Perception of a situation that is problematical, namely, in need of solutions or improvements or betterment, is a function of a given value system, for it is in terms of such a value system that judgments can be made as to the nature of the situation.
  - Values are the dominant commitments of society or the motivating preferences of an individual. They are operationally governed by rules or standards called norms.
  - If a situation is recognized as problematical, it means that there exists a dissonance between the situation and the value system.
  - If planning is viewed as a problem-solving device, then the emphasis of action is to bring changes in the environment while leaving the value system untouched and thus to achieve consonance between the two. If planning is viewed as a continuous organization of progress throughout the environment, then it becomes necessary to effect changes in the value system as well as in the environment to achieve consonance between the two.

  - Changes in the value system are made by establishing new norms in the light of which values can be given new meaning.
  - The redefinition of norms or the invention of new norms is part of planning activity.

- "Plan" refers to an integrative hierarchically organized action construct in which various kinds of decisions are functionally ordered.
  - There are three levels of functional relations between a plan and the environment:
    (a) policy making functions which result in normative planning and are directed toward the search and establishment of new norms that will help define those values which will be more consonant with the problematic environment. In other words, normative planning occurs when the purpose of planning action is to change the value system in order to achieve the required consonance with the environment. The statements of normative planning are derived from values and defined in terms of "oughts".

    (b) goal-setting functions which result in strategic plans wherein various alternative ways of attaining the objectives of the normative plan are reduced to those goals which can be achieved given the range of feasibilities involved and the optimum allocation of available resources.

    (c) administrative functions which lead to operational planning wherein the strategies that will be implemented are ordered in terms of the priorities, schedules, etc., that the situation dictates. Operational planning is that part of the planning structure in terms of which changes in the environment are effected that are purely of a problem-solving nature. (In other words, operational planning need not involve a consideration of value premises.)

2.

The rather abstract and classificatory terms that I was forced to use throughout this paper so as to be able to impose some shape upon the argument have no doubt also caused me to oversimplify it. Let me, therefore, mention some important points I have consciously avoided in order not to lose the main thread of the discussion.

I have, for example, avoided the issue of *power,* the question of who will plan, implement plans, apply plans, although it is one of the central problems that confronts us. And if I am told that power is a "political" issue and therefore beyond the scope of the subject, my answer must be that I disagree: power is personal, social, institutional, situational – it is ecological in the very sense that I have used that term. Power is at the heart of every argument with which planning is concerned. It represents control over one's life and control over one's environment. It would obviously be untrue to say that we have failed to develop many such controls in the societies of the West. We have; but we did so in relation to a single purpose which seems to have dominated all our strivings: the abolition of scarcity by means of mass production and the accumulation of wealth. To this end we channelled all our energies, fashioned all our institutions, subtly reordered all our priorities and values. It is into the meaning of this end that we cast all our hopes and all our notions of progress. It seems not to have occurred to us that abundance itself was but a way-station along the road, and that its very advent would confront us with all sorts of new problems for which everything we built, the wealth, the institutions, the political systems, the civilization would avail us little – because in some deep way they would be almost irrelevant while their momentum would prevent us from thinking of new relevancies. Yet it is these new relevancies that must define the shape of the future.

New relevancies call for new values – not values to be predicted, but values to be created now. To have substance, these new values must be made operational within new institutions. New institutions cannot be invented of whole cloth, set up and told to get going. They have to evolve through change. Such evolution requires that we design some responsiveness *into* our institutions. This, too, is an aspect of planning I have not touched.

Everything that I have attempted to say in these notes adds up to the conclusion that our future cannot be conceived of except in the form of a new and dangerous reality created by population growth, changing and accelerating technology, a reversal of economic-metabolic relationships between man and nature, and the emergence of what more and more frequently is being called the "post-industrial age". It is all this that creates the complexities and the uncertainties I spoke of at the beginning: by "all this" I mean this new world which we, the generation that is riding the wave of change, are finding so big, so strange, so alien and disquieting.

It is my opinion that this situation will continue until what I have called *planning,* namely, the method of value analysis and formation, of policy generation, alternatives construction, choice, decision making and implementation, becomes understood as the core and method of social science.

It is possible that many readers who are used to the hedged formulations of contemporary social science will find my approach in this essay assertive. To this I must answer that to state any fact is an assertion; it is an assertion to perceive something and to say that one has perceived it. I believe that the assertions I have made are beginning to be shared by an increasing number of concerned people throughout the world, although because the facts are new, because their consequences can only be inferred, one has to engage in a great deal of interpretation to make them intelligible. And if it is argued that I have given my interpretation too wide a social base and, as a result, tended to slight the role of individual free will and individual decision-making in these weighty matters, then I shall have to answer that the criticism is well taken and that I believe our problems to be primarily social in character. And if, finally, I am told that I have ignored the old, tested and proved motivations of personal self-interest on which most of our present success is built, in favor of some vague, protean, world-wide approach and view – then, I shall have to borrow answers from two sources and let each reader choose the one that is most meaningful to him. My first answer is taken from the American Blacks who right now keep telling us: "Look around, man! " My alternative retort is a question that Malraux has raised – a question that I, too, always end up asking: "What do I care about what matters only to me? " (1).

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(1) André Malraux, *Anti-Memoirs,* New York : Holt, Rinehart & Winston, 1968. Translation by Terence Kilmartin.

FUTURE-ORIENTED SCIENCE

by

René DUBOS (1)

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In the late 1930's a progressive and prosperous industrial firm in the United States created a research institute for the study of scientific problems relevant to its commercial interests. To glamorize the dedication of the new institute, the firm invited illustrious scholars to discuss the organization of scientific research. The major address was given by the late Abraham Flexner, now remembered for his historic report on the reform of medical education, the great influence he exerted in shaping the policies of the Rockefeller Foundation, and the creation of the Institute for Advanced Studies in Princeton.

The title of Flexner's adress was " On the Usefulness of Useless Research " ; his views of scientific research were based on the following assumptions :

a) Scientific knowledge develops as an autonomous process according to a logic of its own, essentially uninfluenced by social event or considerations ;

b) Unexpected discoveries often occur by accident through the operation of serendipity. The word " serendipity " was created by Horace Walpole, and popularized by the American physiologist W.B. Cannon to denote the discovery of things or facts that were not looked for. In his book *The Way of an Investigator*,Cannon expressed the opinion that serendipity was favored by completely free, unplanned research ;

c) Granted these assumptions, it follows that scientists should be unconcerned with factors external to science in the selection of their problems and should be given as much freedom as possible in the prosecution of their studies. Scientific programs should not be directed or evaluated by outsiders, because scientists work most effectively when they follow their own logic and are free to seize on any accidental observation made by serendipity ;

d) The most esoteric and apparently useless kinds of knowledge are very likely to yield unexpected practical applications. Furthermore, these applications commonly find their place in human problems and activities that are unrelated to the fields of science in which the theoretical studies were made. *Laissez faire*, not planning, should be the philosophy of organization for scientific research.

The assumptions that underlie Flexner's " Usefulness of Useless Research " are naturally congenial to most scientists. In fact, they have been widely accepted not only by scientists but also by enlightened laymen. For this reason, they exert a dominating influence on the administration of scientific research and account for the general reluctance to organize it and to give it direction.

Names such as Roentgen, Becquerel, Curie, Einstein, Fleming have been mentioned *ad nauseum* to illustrate that complete *laissez faire* is the most profitable policy in the administration of scientific research. The immense contributions of science during the Second World War have been quoted as further evidence that intellectual freedom is essential to scientific creativity ; indeed most of the knowledge applied to the development of weaponry and medical procedures during the war had its origin in basic research carried out in uncommitted academic laboratories before the war.

Despite this evidence, I shall attempt to show that the Flexner philosophy of scientific research is inadequate on two accounts. It is based on a faulty reading and interpretation of the history of science. It fails to take into account social preoccupations and the needs of the future. I shall build my argument chiefly from examples pertaining to the biologic sciences, because this is my area of professional specialization. I am convinced, however, that similar examples could be taken from mathematics, physics, or chemistry to illustrate that, although the Flexner philosophy has a limited application to the *tactics* of scientific research, it is invalid when applied to the overall *strategy* of science.

The development of any particular field of science is profoundly influenced of course by forces inherent in the scientific enterprise itself ; these will not be discussed here. On the other hand, social forces unrelated to the logic of science play a large role, probably the dominant one, in determining which fields of science are emphasized at a given time and which are neglected.

I shall select one period of medical history to illustrate how social forces give a direction to the interests of scientists and therefore to their research activities.

Medicine first became scientific through the development of anatomic, physiologic, and biochemical sciences during the first half of the 19th century. This kind of medical knowledge had the greatest appeal for physicians, scientists, and laymen. When Claude Bernard published in 1857 his immensely influential book *Introduction to the Study of Experimental Medicine* everyone was convinced that physiology was about to revolutionize medical practice and therefore would be the dominating force in medical sciences. Yet, the first great medical research institutes were not organized around physiology ; they were devoted instead to the new bacteriologic and immunologic sciences because the most common and most devastating medical problems of the 19th century were caused, or at least aggravated, by microbial infections.

Neither medical schools nor universities were geared for the study of microbial diseases during the 19th century. Special institutions therefore were created for the prosecution of sciences focused on these diseases. In France, the Pasteur Institute was set up in 1888 as a private corporation with an endowment obtained largely from voluntary subscription. In Germany, two separate institutes were established by the government, one for Robert Koch and the other for Paul Ehrlich. In England and Japan, private philanthropists financed institutes to continue the work begun by Joseph Lister and Kitasato. Whatever the country, the scientists in whose name medical research institutes were created had achieved fame in some problem related to the understanding and control of microbial diseases. The first institutes devoted to medical research thus emerged outside and independently of the academic establishment ; they were established and nurtured by private and political bodies to deal with an unanswered social demand.

The institutes of medical microbiology (founded three generations ago) have continued to function in our times, but their relative importance on the medical scene has progressively decreased because microbial diseases are now less important than they used to be. In contrast, research laboratories devoted to the study of biochemical, physiologic, and genetic phenomena have been created all over the world because metabolic and degenerative disorders have become more prominent.

Earlier in the present century, medical scientists as well as a few enlightened physicians and laymen realized that progress in medicine would benefit from greater knowledge of theoretical biology, chemistry, and physics. Recognition of this fact pointed to the need for enlarged concepts of biomedical research and for new kinds of scientific specialists. The Rockefeller Institute for Medical Research emerged from this awareness in 1903. The purpose of its founders was to create facilities and an intellectual atmosphere in which investigators could dedicate themselves to the development of physical, chemical and biological sciences relevant to knowledge of the human body and to the control of its diseases. This broad formula of medical research has been incorporated in the structure of modern medical schools all over the world. In fact, its acceptance is so universal that the trustees of the Rockefeller Institute considered around 1955 that their initial purpose had been fulfilled. They felt therefore that the Institute could more profitably devote itself to other scientific problems of social interest, such as the development of a stronger basis for the study of behavior and the improvement of postgraduate education. The Rockefeller Institute for Medical Research thus rapidly evolved into the Rockefeller University.

The change in emphasis from microbiologic, to chemical, physiologic, genetic, and then to behavioral sciences has a logic which is not inherent in science itself, but is derived from social concerns. The history of science provides many other examples of such shifts in scientific emphasis, which often occur rather suddenly because they are determined by forces originating in the social environment.

Some of the forces that give its direction to the scientific enterprise are political in origin – as illustrated by the relative proportion of public funds allocated to the various fields of science since 1940 and especially post-Sputnik.

It is certain that most human beings are more interested in their biologic and cultural origins than in the exploration of subatomic physics or of outer space ; this is shown by the comparative frequency of topics of conversation among the general public (including scientists), and the sale of books written for laymen. There is no evidence, furthermore, that knowledge of subatomic physics or of outer space is theoretically more important or practically more useful than the knowledge of man's nature or cultures. The decision of governments to support the former aspects of science, and not the latter, is based almost entirely on considerations of power politics and international prestige, rather than on intellectual or humanitarian principles. Neither the logic of science nor the public taste had any part in this decision.

Other fields of science, in contrast, have been developed as a result of public pressures despite the reluctance and even the active opposition of the academic community. Approximately one century ago in the United States, the agricultural experiment stations and the various organizations grouped around the so-called " land-grant colleges " (Morris Act, 1865) were established in each individual state to provide a scientific basis for practical agriculture. This new enterprise, which originated from the efforts of farming interests acting through Congress, was long regarded with contempt by orthodox academics. Yet, the agricultural experiment stations and the so-called " cow colleges " rapidly evolved into great centers of learning which have advanced not only the practice of agriculture, but also many other fields of theoretical knowledge.

The shifts in directions of scientific research brought about by social forces would be of little importance if it were true –as implied in Flexner's address and affirmed by the devotees of serendipity–that great advances in science and in its applications are commonly the unexpected results of accidental findings. However, the statement that discoveries happen more or less by chance is at best a half-truth. It has its origin in the least intellectual aspects of the Baconian tradition and is in fact anti-intellectual.

The belief that scientific planning is useless or even dangerous because *any kind* of research eventually leads to practical applications is also false. I shall limit my remarks on this topic to an anecdote taken from recent medical history.

The introduction of penicillin into medical practice is repeatedly quoted as proof that great practical values often come from uncommitted research and accidental discoveries. Fleming's isolation of his famous mold seems indeed to constitute the perfect demonstration of the usefulness of unplanned, apparently useless knowledge. The details of the penicillin history, however, point to a different interpretation.

For many years, long before he discovered penicillin, Fleming had been working with antibacterial substances and had studied their role in infectious processes. This interest had grown from his long associations with Almsworth Wright in whose laboratory he had begun his scientific career. Fleming was intellectually and even emotionally conditioned by his early scientific experiences to welcome the mold when it fell accidentally on his workbench and contaminated a staphylococcus culture. One of his first experiments after he recognized the antibacterial activity of the crude filtrate prepared from the mold was to test its toxicity for various blood cells. His tests for antibacterial activity and toxicity were direct extensions with the new product of the tests he had carried out many times before with other antiseptics of chemical and biologic origin.

Fleming would not have noted the presence of the mold, or recognized its potential usefulness, if he had been working on intermediate metabolism, the ultramicroscopic structure of collagen, the transmission of nerve impulses, or any scientific problem other than antibacterial activity ; he discovered penicillin because he was interested in microbial diseases, and particularly in substances that inhibit microbes.

Fleming lacked the chemical know-how needed to convert his crude mold filtrate into a usable product, and for this reason his discovery was almost forgotten for some 10 years. H. Florey and A. Chain revived the penicillin phenomenon in 1940 and worked to make it practically available to clinical medicine, because the war had made them become involved in the treatment of combat wounds. The contribution of these two investigators was an awareness of the acute social need for new antibacterial drugs and the development of practical techniques for the production of penicillin from Fleming's crude filtrate.

Penicillin was indeed discovered by serendipity but the initial finding was made and the scientific knowledge required for its use was developed because the scientists concerned had well-defined goals in mind. " Chance ", Pasteur wrote, " favors only prepared mind ". The mind must be prepared not only by scientific training and technical know-how but also by the awareness of social needs.

The research institute dedicated by Flexner in 1939 was founded by a drug firm. It has been highly productive of the kind of science relevant to the production and utilization of drugs and hormones –the products sold by the firm– but it has not contributed much to other areas of medicine. It did not provide the right atmosphere for other kinds of discoveries, nor did it try. This was not its mission.

It is only in rare places that scientific research is entirely free and uncommitted. To be effective, a research group has to specialize in certain fields of science and to neglect other fields. Areas of emphasis are determined by professional interests, availability of funds, public pressures and, of course, by economic necessities in the case of industrial enterprises.

The university scientists themselves are much more susceptible to parascientific influences than they are willing to admit. Pure intellectual curiosity and large theoretical issues motivate some of them, but on the whole the selection of research problems has many other determinants, among them the character of the institution in which the scientist works, the prevalent scientific fashions, and the emergence of new social needs. During the past two decades, for example, the majority of academic biologists have acted on the fashionable assumption that the study of organic macromolecules constitutes the most important and most urgent task of biology. This attitude, however, may soon become outdated, if one judges from the following statement by one of the most eminent and respected leaders of American biology : " Consider for example the study of the biological, behavioral, and intellectual development of the child as an end in itself, with a view to coping ultimately with mental retardation and assuring healthy intellectual growth. Here, we are beginning to explore environmental factors with a wholly new social orientation. Our national program in support of science is entering a phase in which the decision whether to support a given field depends less upon technical considerations than upon social need ".

In science, as in other human endeavors, no man is an island.

The preceding remarks are not meant to imply that there is no place in scientific research for uncommitted curiosity and that only mission-oriented research is useful. All knowledge is useful, were it only because it enlarges man's understanding of himself and of his environment, thus helping him to make his life more intelligent and enjoyable.

Consciously or subconsciously, however, scientists follow directions that are governed by social influences. We must therefore develop a more sophisticated knowledge of human needs and desires if we want science to fulfill its social role. Since even the most prosperous country cannot possibly have enough resources, and especially enough talented and trained personnel, to study all scientific problems that could be profitably investigated, the recognition of social needs and desires implies the establishment of priorities. These are determined in large part on the basis of parascientific criteria which usually involve subjective anticipations of the future.

In 1962, there was held in London an international symposium on " Man and His Future ". At the end of the meeting, Sir Peter Medawar pointed out that there had been little agreement among the participants with regard to either desirable goals for the welfare of mankind or means of implementation. He expressed the view that the difficulty in achieving consensus about planning the scientific aspects of complex social issues results from the very nature of the scientific process. His statement expresses so well the views held by the majority of scientists on the planning of science that it seems worthwhile to quote here part of his remarks :

" This is the thing that has impressed me most about this meeting —the sheer diversity of our opinions... This diversity of opinion is both the cause and the justification of our being obliged to do good in minute particulars. It is the justification of what Karl Popper called 'piecemeal social engineering'. One thing we might agree upon is that all heroic solutions of social problems are thoroughly undesirable and that we should proceed in society as we do in science. In science we do not leap from hilltop to hilltop, from triumph to triumph, or from discovery to discovery ; we proceed by a process of *exploration* from which we sometimes learn to do better, and this is what we ought to do in social affairs ".

If science is really but a step-by-step enterprise, concerned primarily with " minute particulars " (a phrase borrowed from William Blake), then indeed the most profitable and only safe way to use it in the practical affairs of man is to proceed according to what Karl Popper has called " piecemeal social engineering ". However, while Medawar's statement is true, it does not tell the whole truth.

Granted that scientists and technologists have to proceed piecemeal for each particular item of theoretical research or of social application, this kind of approach applies to the *tactics* but not the *strategy* of science. As emphasized in the preceding pages, the kinds of " minute particulars " that scientists investigate and of " social engineering " in which technologists engage are largely determined by factors almost independent of science itself. Among these factors are man's imaginary anticipations of the future. It is correct, as William Blake wrote, that " he who would do good in anything must do it in minute particulars ". But it is equally true, again in his words, that " what is now proved was once only imagined ".

Man is so profoundly goal-formulating and goal-seeking that his life could be said to be teleological. The world " teleology " usually implies a situation in which the future is irrevocably determined because inherent in the present state, but this meaning must be modified to make it applicable to human life. In most cases, man formulates goals even before he has developed means for reaching them, often indeed before the desirability of the end has been established.

In principle, the place of science in teleological thinking about human ends appears simple. Goals are formulated ; various alternative strategies for achieving these goals are explored using science and technology wherever possible ; a cost-benefit analysis of the various alternative strategies is made ; and then finally suitable tactics are developed to implement the strategy that has been selected. The difficulty however is that practically all social and technologic innovations have unexpected secondary effects that can negate the hoped-for results and spoil the quality of life. Once these effects have occurred, furthermore, they are often irreversible. An innovation is like a djinn out of a bottle ; the one command it will not obey is " Get back into the bottle ".

Until recently, it was believed that when social and technologic innovations created new problems, these could be solved by developing suitable countermeasures. The various forms of social and technologic fixes, however, in their turn create new problems. The concatenation : monoculture, pests, pesticides, emergence of new pests, development of pest mutants that resist pesticides, and the toxic effects exerted by all pesticides on man, constitutes a typical example of the endless creation of new problems by the technology-countertechnology approach.

Many analogous examples can be found in the medical field. One of particular relevance to our times is the attempt to control the population avalanche by the widespread use of contraceptives and the systematic limitation of family size. It can be taken for granted that these measures, useful as they are, will create new problems of disease and furthermore will eventually affect the genetic endowment of the human race. With present death rates, the population can be stabilized only if family size is limited to 2.3 children per couple. The consequences of this practice have not yet been evaluated, but it would be surprising if they did not give rise to a variety of new genetic, physiologic, and emotional problems.

Social goals should never be set irrevocably, because the future will certainly be very different from what we can imagine. As will be pointed out again later, planning does not involve only predicting the future, but also structuring social institutions in such a manner that they can rapidly reformulate their goals so as to avoid dangers that had not been predicted, and take advantage of opportunities that had not been imagined.

Everyone agrees that science and technology are responsible for some of our worst nightmares and have made our societies so complex as to be almost unmanageable. A few scholars agree with the hippies that the social problems of the modern world which are science-made cannot be solved by more science. It is romantically attractive to believe that salvation can come only from a change in social philosophy, for example, the reject of bourgeois conventions and a return to the love of nature practised by the early Franciscans. Most persons, however, take a more prosaic view of things. While acknowledging the limitations of the technologic world, they enjoy it nevertheless and hope that science will provide ways to manage it more intelligently. Our ancestors mobilized science a century ago to master nature and to create wealth through technology. We are now asking science to save us from technology. The report of The Daddario Subcommittee in the U.S. House of Representatives (1966) expresses the apprehension and hopes of the public : " The subcommittee believes that we cannot blindly adapt technology to our needs with the traditional assumption that there will be ample time to iron out any bugs on a leisurely shakedown cruise. A bigger effort must be made not only to foresee the bugs, but to forestall their development in the first place ".

The need to focus scientific effort on the social problems of the modern world is eloquently affirmed in the reports of countless committees and task forces. The effort itself, however, remains largely in the form of day dreaming. There is no place or organization where it can become reality, until academic institutions transform themselves or new kinds of research institutes are developed.

Universities are the great reservoirs of classical knowledge and still constitute the most important source of new knowledge. The kind of scientific research they are best equipped to carry out, however, is not likely to provide the specific technical information needed for improvement of modern societies.

The academic structure was organized first for undergraduate education and later modified to provide discipline-oriented training for predoctoral students. This educational task is still its primary responsibility and academic institutions tend therefore to perpetuate themselves in the image of their forebearers. In the opinion of Clark Kerr, it might be possible to keep the academic establishment sufficiently loose and unstructured so that the faculty members could become involved in practical problems of social concern whenever they want. It is probable, however, that the approach through universities will tend to keep things essentially as they are because academic scientists will select for investigation those aspects of the social problems that fit their own professional interests.

The academic investigator insists – as he should – on the right to pursue his own interests irrespective of their social relevance. He tends to be chiefly interested in the inner logic of his scientific discipline and is rarely

" mission-oriented ". Alvin M. Weinberg has recently pointed out that, " As the disciplines making up the university become more complex and elaborate in response to their own internal logic, the discrepancy between the university and the society grows. The university becomes more remote ; its connection with society weakens ; ultimately it could become irrelevant ".

Academic research naturally yields knowledge which often has practical usefulness, but many scientific problems of great social importance remain outside its scope. Even medical schools tend to neglect some of the largest health issues of our time. Like university professors, investigators in academic medicine want to follow the inner logic of their scientific interests, and this often takes them far away from many health problems that do not appear to them of deep theoretical interest yet are very important for the community. As a result of this academic attitude, much of medical research is almost indistinguishable from the kind of biologic investigations carried out in non-medical environments.

The scientific study of most social problems requires, furthermore, a complex integrated approach not readily achieved within the present academic structure. All successful examples of scientific integration in the university are provided by research units focused on special areas of basic science such as geophysics, high energy physics, or molecular biology. These units, which are made up of scientists working in different fields, appear somewhat outside the classical university system, because they are more focused and coherent in their approach to research projects. Nevertheless their outlook is so specialized and remote that they cannot deal effectively with the immediate problems of man in the modern world. They are concerned primarily with science for science's sake, rather than with science in human affairs.

Professional organizations have long realized that it is difficult to carry out the scientific study of their problems within the classical academic system. For this reason, they have been led to establish their own research programs outside the universities. The Agricultural Experiment Stations, the School of Aeronautics at the California Institute of Technology, the institutes devoted to communication theory in the laboratories of the Bell Telephone Company or of the International Business Machines Corporation are but a few of the very numerous illustrations of this trend in the United States.

In medicine, also, it has become apparent that the research attitude and methods suited to the study of general biologic phenomenon are not sufficient to deal with many of the problems that preoccupy the modern world. When these problems become pressing, independent institutes are created to deal with them, just as it was done in the past for the control of microbial diseases. For example. academic physiologists may choose to focus their studies on the phenomena of conduction in isolated nerve fibers, but large research units are being created outside medical schools to investigate the special physiologic problems of aviation and space medicine. Similarly, departments of biochemistry in medical schools may emphasize the intricacies of intermediate metabolism ; but special institutes for the study of malnutrition and of its multifarious effects on human life are emerging in underprivileged countries.

The indirect and delayed toxicity of drugs has become a matter of much concern among physicians, but few are the academic institutions that encourage research in this field. The distribution of medical care constitutes another area in which there is a crying need for fundamental investigations of man's biologic and social needs. The lasting effects of physiologic and psychic experiences during the early phases of development also present problems that are much neglected – even though it is now certain that early influences condition practically all physiologic and mental characteristics of the adult ; early influences also play a dominant role in all pathologic states – ranging from obesity to drug addiction. The remote effects of environmental pollution similarly pose problems of immense magnitude for the study of which research institutes and medical schools are poorly equipped, both physically and intellectually.

It might be argued that the ease of communication will make it unnecessary from now on to create new institutes for the study of special problems. The Neurosciences Research Program carried out through the collaboration of many investigators who work in different parts of the world and meet at frequent intervals provides a pattern that will certainly be imitated in other fields. This type of pan-institutional organization, however, is not likely to prove suited to the study of complex social problems that cry out for solution. Increasingly, the scientific knowledge needed for a more reasonable conduct of human affairs will have to be acquired in mission-oriented research institutes.

The development of mission-oriented science will certainly be influenced by the history of the agricultural experiment stations and of the land-grant colleges associated with them in the United States. The very emergence of these institutions shows that public pressure (in this case from the farming interests) can hasten or even generate the development and teaching of neglected fields of science. The success of the experiment stations in improving the practice of agriculture was due to the fact that they facilitated a rapid feedback between practical problems faced by the farmers and the knowledge of laboratory scientists. The feedback was accelerated by the creation of extension services in which practitioners could formulate questions and take the theoretical answers to the field. When such theoretical answers were subjected to the acid test of practical conditions, they forced the recognition of new theoretical problems that were taken back to the laboratory for further investigation.

The interplay between theoretical knowledge and practical application is not a new phenomenon. In fact, it may well have constituted the most important factor in the history of science. However, this interplay is acquiring special importance at the present time because of its relevance to the development of scientific policies and of social planning.

Planning scientific research on the basis of social and economic criteria is of course commonplace in large industrial firms, but is only at its beginning in governmental institutions. William D. Carey, of the Bureau of the Budget, recently gave the outline of a " Social Merit Matrix " designed as a preliminary model of a technique to be used by government for the comparative evaluation of competing research programs. According to Carey's scheme, the social merit of scientific research programs would be measured in terms of their relative contributions to the different types of national goals, as outlined in Table I.

It will be difficult of course to achieve consensus as to the relative importance of the various goals entered in the matrix. The supersonic transport plane (SST) provides an important test case – because a fairly simple one – to illustrate how conflicting social criteria complicate the evaluation of scientific technology.

According to an advertisement paid by a spokesman for aviation, " Supersonic supremacy is the absolute condition of America's future security... It must grow with major advances ". This statement does not promise that supersonic planes will confer any new blessings upon us, only that they will help us advance in power – whatever this may mean. Other groups, however, are defending the view that the price to be paid for any advantages from supersonic speed will be far too high. They emphasize that the hours of flight saved by the few thousand officials, business tycoons, or simply the idle rich who will fly on the SST will not compensate for the disturbances caused to the millions of people exposed to the sonic boom on the ground. Many other conflicting aspects of supersonic flight have scientific determinants which must be evaluated in the light of social values.

All political decisions involve similar scientific dilemmas. For reasons of national security and perhaps even more of international prestige, the United States considers it essential to maintain nuclear superiority over the rest of the world. However, while this is being achieved at the cost of tremendous

Table I

SOCIAL MERIT MATRIX

		RESEARCH PROGRAM				
Value Category	Weight	Desalination	Population Control	Weather Modification	Oceanography	Lunar Exploration
ECONOMIC						
Health and welfare	3	x	x	x		
Technological gain, business expansion, full employment	10			x	x	x
Conservation of resources	10	x	x	x	x	
Return on investment (cost-benefit)	2	x		x	x	
CULTURAL						
Exploration	5				x	x
Understand environment	5			x	x	x
Enrich education	10					
Improve human relations	5		x			
POLITICAL						
National prestige	2	x				x
International understanding	5				x	
Problem-solving in underdeveloped countries	3	x	x	x		
Cold war advantage	15			x	x	x
Relative Program Values		20	21	48	52	37

expenditures of money and scientific talent, the United States has one of the highest rates of infant mortality and lowest male life expectancy among the countries of Western civilization. Little is being done, financially or scientifically, to lower death rates in these age groups, because health standards are judged of minor importance when international prestige is at stake.

Scientific research is never entirely value-free because science needs the support of society and furthermore affects most social decisions. The large amount of talent, time, and funds devoted to any one given program necessarily limits the support that can be given to another program.

The greatest difficulties in the organization of mission-oriented scientific research programs may not be administrative in nature, but rather come from the need to develop new attitudes in scientific philosophy. Over most of the world, the typical scientist is trained to think of science not as a means but as an end ; his professional ideal is science for science's sake. If social problems are considered from this point of view, the scientist is, *ipso facto*, the best judge of their relative importance and of the best manner to solve them. This is not the case, however, when the same problems and their solutions are considered with regard to their social relevance.

Mission-oriented research has objectives that are societal rather than scientific. Social criteria, not scientific ones, determine what kinds of problems are important and what technical solutions are most appropriate.

Scientists will not readily reconcile themselves to this change of emphasis. Their unhappiness will come not from a lowering of scientific standards or a scarcity of interesting problems. In fact, applied science is in many cases more demanding intellectually than are the so-called purely academic sciences. The investigator in applied science must accept the complexities of the natural world instead of selecting problems on the basis of their convenience for experimental analysis, their suitability for rewarding speculation, or their opportunist appeal.

Scientists have learned from long experience, however, that they are happiest and most productive when they have the freedom to select their areas of activity, work according to their temperament, and follow whatever interesting phenomena turn up in the course of their studies.

The shape of things to come may be seen in a recent analysis of the present and future role of National Laboratories in the United States. A. M. Weinberg, who has guided the research course of the Oak Ridge National Laboratory for the past 18 years, points out in one of his books that mission-oriented scientific establishments such as those of the Atomic Energy Commission age rapidly because their missions run out. Their laboratories need new assignments to retain their vitality. The very word assignment, however, implies an attitude toward research very different from that held by the majority of academic scientists.

One may anticipate that the scientific structure will evolve even further than suggested by Weinberg, and that much of mission-oriented science will be increasingly carried out by task forces made up of assorted scientists possessing diverse skills and organized around problems-to-be-solved. Temporary project groups, rather than permanent stratified groups, would characterize this type of mission-oriented science. Living in temporary work systems and having to cope with rapid changes would certainly create strains that present-day scientists, working either alone or in small stable groups, have much less occasion to experience.

In addition to the unpleasant changes that mission-oriented research will cause in the professional lives of scientists, there are potentially dangerous changes that are likely to occur in the scientific process itself. The formulation of objectives determined outside the research groups on the basis of non-scientific criteria may rob science of its own self-generating intellectual creativity and excitement. In the past, this very excitement did much to generate objectives that were both worthwhile and realizable.

All discussions of science planning are inevitably naive because we know so little concerning the social workings of the present scientific structure and of the manner in which scientists will respond to the various forms of organization and control of science that are now being contemplated. It can be anticipated, however, that working scientists will function most effectively in mission-oriented institutions if they have a chance to become intimately and vigorously involved in the formulation of the social objectives to which their work will contribute. In fact, the dynamic, on-going character of the scientific enterprise may well give scientists the opportunity to prevent long-range planning from slowing down social evolution.

Whatever the type of teleological thinking and long-range planning in which planners engage, social goals should never be set irrevocably. They have to be altered, of course, when unexpected difficulties stand in the way of their realization or make them less desirable than first appeared. More importantly perhaps, they should be altered when new facts and new outlooks point to the possibility of other more desirable human ends.

In all human societies that retain their dynamism, means and ends are in constant interaction and form an uninterrupted continuum. This is particularly true where science plays an important role in human activities. In the very process of defining problems and attempting to find solutions for them, the scientist commonly introduces into the situation new factors that point to the possibility of modifying the ends he was helping to achieve. " It is characteristic of science ", Pasteur wrote, " that it continuously opens new fields to our vision ". For example :

Scientific technology has developed procedures that protect man from stresses and relieve him from the necessity of monotonous efforts ; however, physical and mental health deteriorate when man cannot expand his energies in some acceptable manner ; the new goal then becomes the creation of an environment rich in opportunities for enjoyable and worthwhile expenditures of physical and mental capacities.

Another example is provided by the fact that changes in the ways of life and advances in medical science have gone far toward preventing childhood diseases , this has caused a marked acceleration of anatomic growth and sexual maturation, and probably also of mental development ; such acceleration in turn suggests that different social attitudes and different types of environment might enable human beings to achieve a more complete expression of their potentialities.

Human institutions fulfill two different, but complementary roles. One is to promote stability of purpose against the disruptive pressure of daily events ; the other is to facilitate and accelerate adaptive responses to changes in the environment and in the characteristics of the social group. Universities and research institutes have been remarkably succesful in assuring the intellectual stability required for the long-term effort which has produced our scientific technological civilization. In contrast, they have dealt much less effectively with the new problems created by this form of civilization, and they have done little to explore the consequences of biotechnologic changes for man's future.

Admittedly, a few university programs are attempting to devise tactics for anticipating the consequences of the exploitation of the earth's resources so that we do not have to face continuously, astonished and unprepared, a succession of environmental crises. This kind of prediction, however, is not sufficient to deal with the problems of a future-oriented, rapidly-moving society.

There is a " logical " future which is the expression of natural forces and antecedent events. On the other hand, there is also a " willed " future which comes into being because man makes the effort to imagine it and to build it. H. G. Wells wrote in *A Modern Utopia* " Will is stronger than Fact , it can mold and overcome Fact. But this world has still to discover its Will ". What H. G. Wells meant by " *Will* " is the image of a future which is really desired but one which is also possible. Such an attitude corresponds, I believe, to what Ozbekhan has in mind when he speaks of long-range *normative* planning (" the ought to "). A scientific institution truly oriented toward the future would attempt to predict the likely consequences of certain courses of action ; more interestingly, it would also help man to recognize the continuously evolving potentialities that are created anew everyday by surroundings and events.

Universities have been established to transmit classical knowledge and to acquire new but timeless knowledge. Research institutes as presently constituted deal with the problems of the present and of the predictable future. Now that the technologic environment and social institutions change at increasingly rapid rates, we must develop institutions to study how man can best make use of the possibilities among which he can choose, to determine his long-range future, not as a passive witness but a wilful creator.

INTEGRATIVE PLANNING OF TECHNOLOGY

by

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1. The Nature-Man-Society-Technology System

Technology, from the mastering of fire and from the earliest beginnings of primitive weapons technology, is the instrument which enabled man to depart from purely biological evolution and to enter a psycho-social phase of evolution which he shares with no other creature of Nature. In its origins and use throughout the millenia, technology was the tool that permitted man to emancipate himself from Nature, to domesticate Nature – in brief, technology became the tool for Nature engineering, as we might call it today. But it also became instrumental in the attainment of higher stages of psycho-social evolution up to the complex and integrated society of today.

We may thus, in a simplified picture, distinguish between four basically different areas amenable to engineering – areas to which we may apply our capabilities of planning, design and operation through which we can actively introduce change : Nature, man, society, and technology (see Fig. 1). It is of the utmost significance that technology appears here not only as change agent, but in its full ambivalence as an instrument for effecting change and an element of planetary development in its own right. Technology is the predominating means to engineer Nature, society, and (to an extent which is only marginally realised at present) man himself , but technology is also the possibility to build an artificial world supplementing or even replacing Nature and introducing any number of man-made elements into the human environment. It is this ambivalence of technology which forces us today to attempt control of the development and application of technology in an integrative way, taking into account the full scale of interrelationships of technology engineering with the other forms of engineering – Nature, human and social engineering – with which it forms an indivisable system.

The decisive factor in the current development, if we still consider the simplified picture given in Figure 1, is the rapid and almost independent growth of the " Technology Engineering " area *per se*, and its one-sided influence on the other engineering areas, primarily on the slowly developing area of social engineering and on the area of Nature engineering which is frequently disregarded in planning. Technology engineering is affecting the insufficiently known area of human engineering in an unknown, but certainly important way. The uncontrolled growth of this one element in our overall system, technology, is now about to assume the characteristics of cancerous growth, disturbing and repressing the healthy development of the other parts of the system.

Another important factor is the powerful *positive feedback* which technology, in its role as change agent, obviously introduces into Nature and

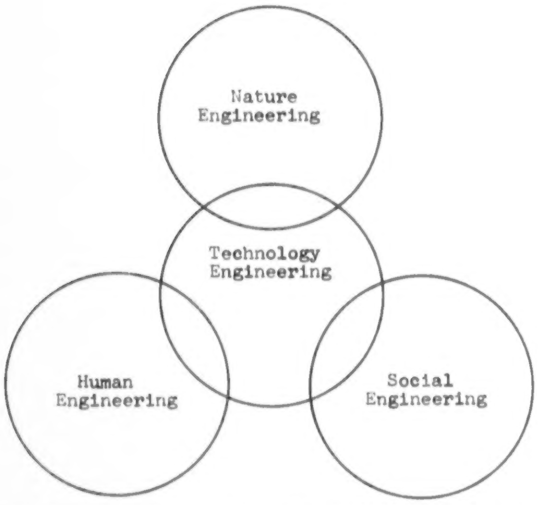
Nature
Engineering
Technology
Engineering
Human
Engineering
Social
Engineering

Figure 1 - The interaction of four different forms of engineering. Their "autonomous" development endangers the stability of the total system.

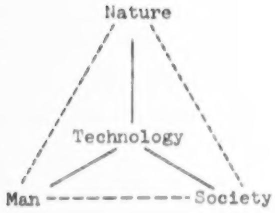
Nature
Technology
Man
Society

Figure 2 -
The Nature-man-society-technology system can be broken up into six "bi-polar" sub-systems which facilitate the definition of systemic functions. Three of these sub-systems involve technology (full lines), three do not (dotted lines).

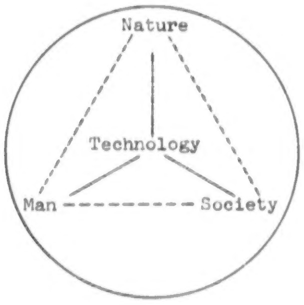
Nature
Technology
Man
Society

Figure 3 -
Ecological engineering establishes control over the total integrated system; it deals with the inter-relationships between the functions defined within the six sub-systems.

social engineering, and also into human engineering, if we consider the population explosion as a result of health and nutrition technology. The engineering possibilities in these areas are multiplied, the objectives become diversified, changes once introduced become irreversible and give rise to more changes, the dynamics of change are accelerated – in brief, the system (which is equivalent to man and his environment) tends to develop dynamic instabilities which create the danger of catastrophical excursions and subsequent stabilisation on a much lower level of psycho-social evolution only, characterised, *inter alia*, by a lower state of integration.

There can be no doubt that this positive feedback, provided by technology, has contributed enormously to the acceleration of mankind's development over the past millenia and particularly over the past few centuries, and has introduced the vast variety of possibilities which enables us today to choose among a wide spectrum of anticipations (" possible futures ") and to formulate our goals in terms of " quality of life ". However, there are numerous indications pointing to the fact that the destabilising effect of positive technological feedback, for long restricted by the rate of technological innovation and by the available resources, has already seriously distorted development on our planet and is creating the danger of complete loss of control. We notice the alarm signals in the form of various *alienations* : the alienation of man from technology, from society and also from Nature, the alienation of society from technology, etc. Herbert Marcuse's accusation of technology (to quote only one example of some actuality) as the non-political rationalisation of totalitarianism refers to such an alienation caused by a belief in the autonomous development of technology, which is bound to dominate the Nature-man-society-technology system.

What negative feedback can be introduced to counteract the powerful positive feedback from technology and stabilise the dynamic development on our planet sufficiently to avoid dangerous fluctuations ? Nature can play such a role only locally and marginally. It could again become a major restrictive factor only after the population explosion has led to a catastrophical situation (for example famine reducing the world population, etc.). The real and undivided responsability for the continuity of mankind's evolution falls back on man himself and on the amplification of his capabilities through the institutions of society. There can be no doubt that it is in mankind's power to obtain the necessary control through the implementation of integrative planning. The emergence of a new planning philosophy, emphasising the normative aspect of planning and the possibility of actively shaping the future on our planet, has not come too early to check a development which is already characterised by the unmistakable signs announcing a major crisis.

2. The " Bi-Polar " Sub-Systems and Functions for Technology

A closer look at the Nature-man-society-technology system shows that it can be broken up into six " bi-polar " sub-systems, each of which represents the integration of two of the four basic elements (Fig.2). Three of these sub-systems contain technology as one of their elements : these are the Nature-technology, the man-technology, and the society-technology sub-systems. Three more leave technology out : these are the Nature-man, the man-society, and the Nature-society sub-systems.

Control over a specific systems component can be achieved only if we go to the next higher level of abstraction and formulate our objectives at that higher level. We can satisfy this generally valid rule, particularly suited to our purposes, by looking at the *outcomes of technology* within the above " bi-polar " sub-systems. In other words, we look at the *functions* technology performs in these sub-systems and we become detached from technology in two important ways : (1) we are now free to consider different technologies contributing to these functions, and to compare the merits of these contributions – and in turn the merits of specific technologies in the context of such a " bi-polar " sub-system ; and (2) we can now apply normative thinking to functions of technology (needs, impacts, side-effects, etc.) in sufficient transparency to bring our human value systems into the play.

One decisive factor of such a function-oriented strategic planning framework, as we shall now call it, is the presentation of alternatives based on different technologies ; strategic decision-making on this basis then consciously chooses between a variety of feasible technologies, selecting some, and discarding the others. The criteria for decision-making, based on the comparison of characteristics which the strategic alternatives have in common, have now shifted from relatively superficial and peripheral features of specific technological developments, such as material and non-material resources and economic and performance estimates – because technologies themselves cannot be compared with each other – to the outcomes of different technologies in a systems context, which, of course, includes economic and performance aspects. These outcomes, it should be noted, can be readily compared with each other in qualitative terms, with the possibility of developing quantitative frameworks for comparison. A straight comparison between the traditional internal combustion engine car technology, and the electric, hybrid, steam-engine, etc. car technologies would emphasise such characteristics as unit cost, operating costs, and various performance parameters (speed, acceleration, etc.). Consideration under the function " urban transportation ", in contrast, would not neglect the above characteristics, but attempt to bring out clearly the effects on the society-technology system (air pollution, noise, etc.) and on the Nature-technology system (degrading of fossil fuels through combustion versus stored electricity from primary nuclear energy, etc.). A wider range of technological alternatives would perhaps disfavour the car as a possible urban transport technology altogether. The choice made is then, above all, that for a specific quality of life.

We have thus obtained both a higher degree of comparability at strategic level and the possibility to plan in terms of the quality of life. Another important factor is that we are planning not only for the development of a specific technology, technological product or process, but for the integrated chain of technological development and its effect in the system – or, to put it in Harvey Brooks' terms, for both vertical *and* horizontal technology transfer (1). With the present shift of emphasis from vertical towards horizontal technology transfer ("making better use of existing technology") this integrated planning will become ever more important and inevitable. We may even go considerably further and view technological forward planning now as the *integrated planning of change through technology* in one of the " bi-polar " sub-systems, for example comprising the planning for social change and for new institutions in the society-technology sub-system. It is evident that this new look at technological planning entails tremendous consequences.

A further important feature of function-oriented strategic planning becomes clear from the above : this is the enforcement of *long-range forecasting and planning* in accordance with the long-range objectives that are implied in the functions for technology. Not the emergence or planned realisation of new technology determines the time-frame (as it would, if we focussed our attention solely on technology itself), but the change introduced by technology into the system. It is not surprising from this viewpoint, that 50 years or more is to be considered the proper time-frame for strategic technological planning in many contexts. Particularly long time-frames can be readily established for the Nature-technology sub-systems and are already, implicitly or explicitly, governing such developments as nuclear power (e.g. emphasis on fast breeders to replace the low-burning reactor generation).

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(1) Vertical technology transfer signifies the movement from a scientific principle over elementary new technology to new technological products, processes, systems etc. ; horizontal technology transfer signifies the diffusion and application at a given level of the vertical transfer process, in particular the diffusion of technology (e.g. computer technology) and its application to new ends (e.g. specific industrial control and automation purposes) as well as the creation of new services (e.g. information retrieval services).

A closer look at the three " bi-polar " sub-systems comprising technology may give us a more precise idea of such a function-oriented framework of thinking :

(1) *The Nature-technology sub-system* : The functions in this sub-system are at the historical origins of technology. In man's fight against an inimical environment and against scarcity, he used technology first with striking success. We might attempt to formulate a few functions in this sub-system in the following way :

(a) *" Domestication " of Nature* for man's purposes : Agriculture has provided the outstanding success in this area for the past 5 000 years, including the more recent modification from a closed plant/animal system with dirt fertilisation, to an " open " system receiving inputs in form of chemical fertilisation. It is significant that the necessary modifications which ought to be introduced today to adapt agriculture to tropical climates, are not pursued with the same vigour and the same success. New forms of biological food production, such as the growth of Single Cell Protein on petroleum or other organic substrates, may soon have to be integrated with the agricultural system. Ocean harvesting (which does not yet constitute " domestication ") could be extended to controlled mariculture, with greatly increased specific outputs. Hydro-power, finally, has to be considered as a type of " domestication " which was only partly successful, in so far as it affected the natural and ecological stability of certain regions ; also, it reaches the limits of exploitation relatively soon.

(b) *Ecological stabilisation,* or *the conservation of the reproductive capabilities of Nature* : In respect of this function (which is only now becoming recognised), the positive feedback of technology has already had some devastating effects. A number of irreversible changes have been introduced – some of which have been going on for centuries – and led to the destruction of forests and fertile lands, the eradication of animal species, drastic change in regional animal ecology, the pollution of lakes and the (partly irreversible) destruction of their natural biological purification mechanism, the considerable increase in the carbon dioxide contents of the air over the past few decades of world-wide industrialisation, the creation of drought zones due to high local energy consumption, the lowering of the ground water-level due to over-exploitation and the resulting increase of salinity (in coastal regions), etc. Many of these irreversible, or only slowly reversible changes in Nature, have introduced dynamic processes widening the gap from the original stable state much further – a most undesirable and unforeseen positive feedback, that may eventually leave us only the possibility of supplementing a partly destroyed Nature by an artificial world, and thus turning us back to technology which was at the origin of the destabilisation.

(c) *Utilisation and availability of natural elements, compounds and materials* : It is obvious that here natural reproductivity cannot cope with the rate of utilisation by man. The emphasis ought, therefore, to be placed on the exploitation of new natural resources (bottom of the ocean, etc.), recovery cycles, e. g. for metals, possibilities to supplement and replace scarce natural materials (as has been done with some building materials), and on the proper use of natural compounds and materials according to their most valuable potential (upgrading of the macromolecules available in petroleum for purposes of petrochemistry and food production, etc., instead of downgrading them for combustion purposes).

(d) *The physical adaptation of the natural environment* : The possibilities of water desalination, air conditioning, transport systems, and new forms of shelter, open up a number of possibilities to make new parts of our planet habitable. It seems, however, that with this there is also an irresistible temptation at work to over-shoot the target and plan for domination by a more or less completely artificial environment which technology engineering lets appear to be feasible in the near future. Living in R. Buckminster Fuller's geodomes (conceived so as to float in the air even) in eternal sub-tropical climate, with Commander Jacques Cousteau under the surface of the sea, with some Japanese city planners on the surface of the sea, or with Fritz Zwicky and others on the moon and on planets, certainly would, while creating physically habitable environments, on the other hand interfere drastically with the society-technology and the man-technology sub-systems, probably over-stepping the absolute limits set by them.

(e) *The creation of a " biological landscape "* as our final example of possible functions within the Nature-technology sub-system, is perhaps the most complex task technology faces , it is also closely related to aspects of the Nature-man and Nature-society sub-systems. The target would be, in short, to replace the ugliness of the quickly spreading urban-industrial landscape by the equivalent of the landscape which, in rural societies, is determined by agriculture. Although agriculture, as a form of Nature engineering, has changed the original natural landscape considerably, it did not break man's relationship with Nature. On the contrary, looking over fields and pastures, we have a unique feeling of being at peace with Nature, of having shaped an " anthropomorphous " Nature. In contrast to that, the artificiality of our urban-industrial landscape and the visible predominance of pure technology engineering, do not strike us in the same way, but give rise to a feeling of alienation.

(2) *The society-technology sub-system* : This sub-system is now quickly coming into the focus of attention of governments, of industry and of the academic community. Technology is accepted today as the most powerful change agent at work in our society, as regards both its developed and its developing part. It is in this sub-system that functions are most readily recognisable and recognised. Suffice it to name a few of them in arbitrary order, without going into more detailed discussion : communication, transportation, education, energy generation and transmission, public health, automation, security, economic development, population control, food production, urban development and rehabilitation. It is evident that many of these functions overlap or are mutually dependent on each other, such as the functional complex communication – transportation – urbanisation – automation (improved means of communication and automation, such as the home computer console and satellite educational TV, may render traditional transportation needs obsolete, and influence urbanisation accordingly). The effectiveness of global population control evidently influences greatly the requirements for many other functions. In the society-technology sub-system, the functions represent a less rigid planning framework than those in other sub-systems. This is due to the continuous rapid change of society itself, i.e. to the pace of social evolution. The above-mentioned example already gives a hint at the " mobility " of the transportation function where the focus may shift, in a few decades' time, from present transportation needs for professional purposes to recreational and similar purposes. Or, with increasing automation, the communication function may take on new aspects such as exercising one's profession by communicating from home with professional centres.

An important aspect of technological development is its conscious planning and utilisation for the purposes of improved social engineering (information and feedback systems such as the " daily voting " system, mass media, urban experiments, etc.).

The United States Government's Planning-Programming-Budgeting System (PPBS) and a variety of industrial planning schemes and " innovation emphasis structures " have already made an impressive start in function-oriented strategic planning in the framework of the society-technology sub-system.

(3) *The man-technology sub-system* : Frequently neglected, or subsummed under the society-technology sub-system, this sub-system is likely to provide the most stringent negative feedback elements to control technological development in an integratively planned overall system. The relationship of man to technology is different from society's relationship to technology. The one-sided concern over technology's functions *vis-à-vis* society have led to the restriction of man's freedom (increased urban traffic leading to reduced personal mobility, etc.), to the invasion of his privacy (street noise, radio and television, etc.), to the deterioration of his environment (through increased social functions in urban living, etc.), and to stresses imposed on his physical and mental state. The greatest danger arises from the fact that the physical and psychological limitations which become effective at the man-technology interface, are so poorly known. As René Dubos points out, the science of environmental biology for the human species has started only recently for military and space purposes. We do not know what degree of artificiality we can support in our environment, but some of the first results of the new discipline of neuropsychobiology seem to indicate that we are close to some absolute boundaries, or have already over-stepped them. The same may be suggested by mental sickness in urban environment, and by such phenomena as mass hysteria, increasing violence, crime and other forms of alienation, and the increasingly neurotic behaviour found in the cities primarily among the young. Over the past millenia man has shown a remarkable capacity for adaptation to a more artificial world. But the question now is whether he can adapt further at the greatly increased rate of change and newly introduced aspects of an artificial world, and whether there are absolute limits to his adaptability.

One may believe that useful functions for this sub-system may be defined, for example, in the following way : physical health, mental health, adaptation to physical environment, adaptation to psycho-social environment (which, of course, also belongs to the man-society sub-system), personal integrity (particularly privacy – in which area the invasion by technology may go much further than it has done so far, providing incentives for the development of such devices as personal information filters).

Failure to investigate and respect the boundaries set for the man-technology sub-system would lead in the most direct way to irrational response, and a dramatic aggravation of the crisis in the dynamically unstable overall system Nature-man-society-technology. It would also render totally ineffective the good, but isolated, planning in the society- technology sub-system which is coming into the spotlight today. The situation is particularly dangerous, since planning in the man-technology sub-system can hardly start in a serious way before much more basic research into the man-technology interface has enriched our information basis for this type of planning.

The vast spectrum of possibilities of engineering man through technology is only now becoming visible. With biology opening up the potential to change the biological foundation of man, we are given, in principle, a powerful means of changing the relationships within the overall system, for example by adapting man to specific natural or artificial environments, by eugenics, or by a considerable extension of his life span. On the other hand, we may also hope to find the means to counter the degeneration of the human species which, otherwise, would result from the elimination of natural selection processes for man. The basic potential and limitations of " human engineering " in this direction also are only poorly known. Proceeding without sufficient information and without a good deal of wisdom may be disastrous, but so may be not proceeding at all. We have partly destroyed Nature and partly messed up society – we shall soon be able with equal ease to change or destroy the human species.

Apart from the three sub-systems discussed above in which technology is involved directly as one of the two " partners ", there are three more sub-systems which do not include technology directly. They will be enumerated only briefly :

(4) *The Nature-man sub-system* : Much of the challenge to man to create an " anthropomorphous " world reflects, of course, the potentials and limitations implicit in the Nature-technology sub-system. It should be noted, however, that the biological platform of man is just one aspect of his existence as a creature of Nature. Other aspects have to do with the overwhelmingly important psychological relationship of man with Nature, with the archetypal character of his thinking and his irrepressible sub-conscious image-forming (which suffers so badly under the imposition of images through technology), philosophy, religions, and the arts. Suffice it to say that " human fulfilment ", the value which is coming back to us today so powerfully, depends on the good " management " of this sub-system more than on anything else, thereby also imposing severe limitations on the development of an artificial world through simple technology engineering.

(5) *The man-society sub-system* : The types of alienation which become visible in this sub-system frequently have their origins in technology introduced for the sake of the society-technology sub-system, especially in the context of urban living. The adaptation of and to the psycho-social environment of man – including all his psycho-social creations, such as political systems, nations, economy, etc. – here come into focus. Education is a particularly important function which also creates needs for new technological developments.

(6) *The Nature-society sub-system* : An important element here, which generates big demands on technology, is exploration, which could, ideally, provide the challenge of " worthwhile adventure " which may become badly needed in a world going to higher degrees of automation and longer periods of leisure time. In this respect, the expensive space adventure has so far been improperly represented. Nigel Calder's (1) notion that the challenge of " worthwhile adventure " may be found in the observation of unspoiled Nature, once technology (especially non-agricultural food production technology) generates the possibility of such land use, or better non-use, illustrates the wide margin of interaction with technology engineering. The " biological landscape " function, discussed above under the Nature-technology sub-system, also impinges on the Nature-society sub-system, of course.

3.The Vertical and Horizontal Integration of Planning – Towards Integrative Planning for Ecological Engineering.

The formulation of planning objectives in terms of functions within " bi-polar " sub-systems gives us the possibility of controlling the variety of feasible technologies by treating them as strategic alternatives to achieve given functional objectives. This is not yet sufficient. It has already become obvious that these functions interact with each other in a very complex way, and that also the six " bi-polar " sub-systems interact with each other. If we take, for example, the function of creating a " biological landscape ", all other functions involving land use (food production, urbanisation, transportation, etc.) are affected, and a good solution cannot be found by satisfying only one isolated function. Also, functions may be " mobile " over time, especially in the society-technology sub-system.

Integrative planning, ideally, will attempt to go again to a higher level of abstraction and to gain control over the interplay of the functions. The first

(1) Nigel Calder, The Environment Game, London 1967.

step leads to dealing with entire " bi-polar " sub-systems and an integrated approach to, say, the society-technology sub-system. Whereas this is useful if we consider, for example, the planning of social change through technology and of social institutions in an integrated way, we have still to make a further step and integrate the functions that come under all sub-systems. This is sketched in Figure 3, where a common planning and control system deals with the six sub-systems in an integral way. We could call integrated action at this level " planetary systems engineering ", if this would not suggest other meanings – but a proper name may also be found in *" ecological engineering "* using the term ecology here for the totality of the relationships in a viable system. The continuously changing images guiding planning and control at this level are the discrete " possible futures ", which Ozbekhan calls " anticipations ", Kahn " alternative world futures " and de Jouvenel " futuribles ".

It must be said right here that we are far from being sufficiently advanced to have a planning methodology to deal with the total area embraced by " ecological engineering ". Our capacity for systems analysis stops at single functions (such as food production on a world-wide scale), if it can handle them at all. However, the nearly unlimited capacity for systems simulation makes it possible to check the outcome of certain combinations of functions in the overall system, or of technologies within a function.

In other words, we are always to some extent capable of integrating our plans *vertically* – from technological options over functions to complete anticipations – and of checking the outcomes of certain combinations. But we are not capable of going beyond single functions in the systematic *horizontal* integration of our plans. This need not bother us if we could deal with the outcomes of specific technologies and the outcomes of specific strategies for the development of entire functions as if they were unambiguously defined building blocks. Unfortunately, this is not so. The outcomes of a selected technology, or a selected strategy for the development of a function, vary according to the other technologies, or strategies, introduced into the overall system, although in different degrees of sensitivity. There is no escape, at present, from using increasingly partial information as a base, the higher and the more integrative planning becomes. One may remember here, for example, the uncertainties introduced by the not very well known man-technology interface.

Looking at the *vertical integration of technological forecasting and planning*, we have thus defined the following levels of objectives :

technologies
functions
(" bi-polar " sub-systems)
anticipations.

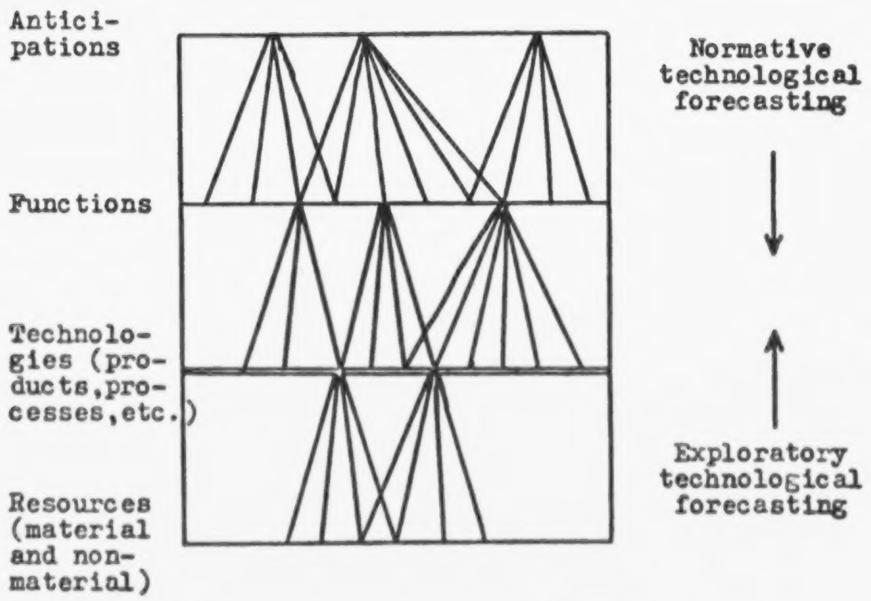
Antici-
pations
Functions
Technolo-
gies (pro-
ducts,pro-
cesses,etc.)
Resources
(material
and non-
material)
Normative
technological
forecasting
Exploratory
technological
forecasting

Fig.4 . Targets for planning and forecasting. Each technology can, in general, be realized by different combinations of resources, and has a variety of outcomes; each functional objective has a variety of technological solutions. "Commonalities" are indicated schematically. The three layers of the figure correspond to tactical, strategic, and policy planning. Technological forecasting implies simulation runs through every possible combination of unbroken vertical lines.

Although objectives may be formulated for entire sub-systems, they do not define a separate planning level in strict terms. Their introduction mainly serves a clearer formulation of functions. It would be artificial, for the interactions between functions at the next higher planning level, to exclude obvious inter-relationships between functions of different sub-sytems. With the present emphasis on the society-technology sub-system, we are used to dealing even with functions from the Nature-technology sub-system (e.g. environmental control) and the man-technology sub-system (e.g. noise control) as " social " functions.

We have, in principle, to plan on the basis of feedback loops between a number of functions which may belong to different sub-systems : some of these feedbacks between functions may be very strong and dominate the overall systems outcome of the introduction of a specific technology, and other feedback relations may hardly matter.

In short, it appears sufficient for most technological planning purposes to distinguish between three levels of objectives : technologies, functions, and anticipations. Figure 4 gives a schematic picture of the scope of technological planning. A specific technological realisation (a product, process, or technological system) corresponds to a multitude of outcomes as well as, in general, to a multitude of resources to be employed for its realisation. Before deciding on the development of a specific technological realisation, one should be able to simulate any combination of links between the resources and the anticipation level – not just for one possible technological realisation, but also for all other technological realisations which are related to the same functions. Only in this way can the *technological decision-agenda*, the aim of technological forecasting at strategic planning level, become really informative as to the alternative decisions possible.

Clearly, such " complete " simulation runs can be made only for technological developments which have reached an advanced stage (1). " Incompletely filled " pages will therefore have to be added to the decision-agenda, which may nevertheless influence the decisions considerably.

Figure 5 attempts to depict schematically the vertical integration of technological planning in an industrial context. It shows the feedback cycles between the corporate environment – which will reflect mainly the society-technology sub-system – and the science and technology base at each

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(1) See also Fig.2 in the paper by Robert H. Rea in this volume.

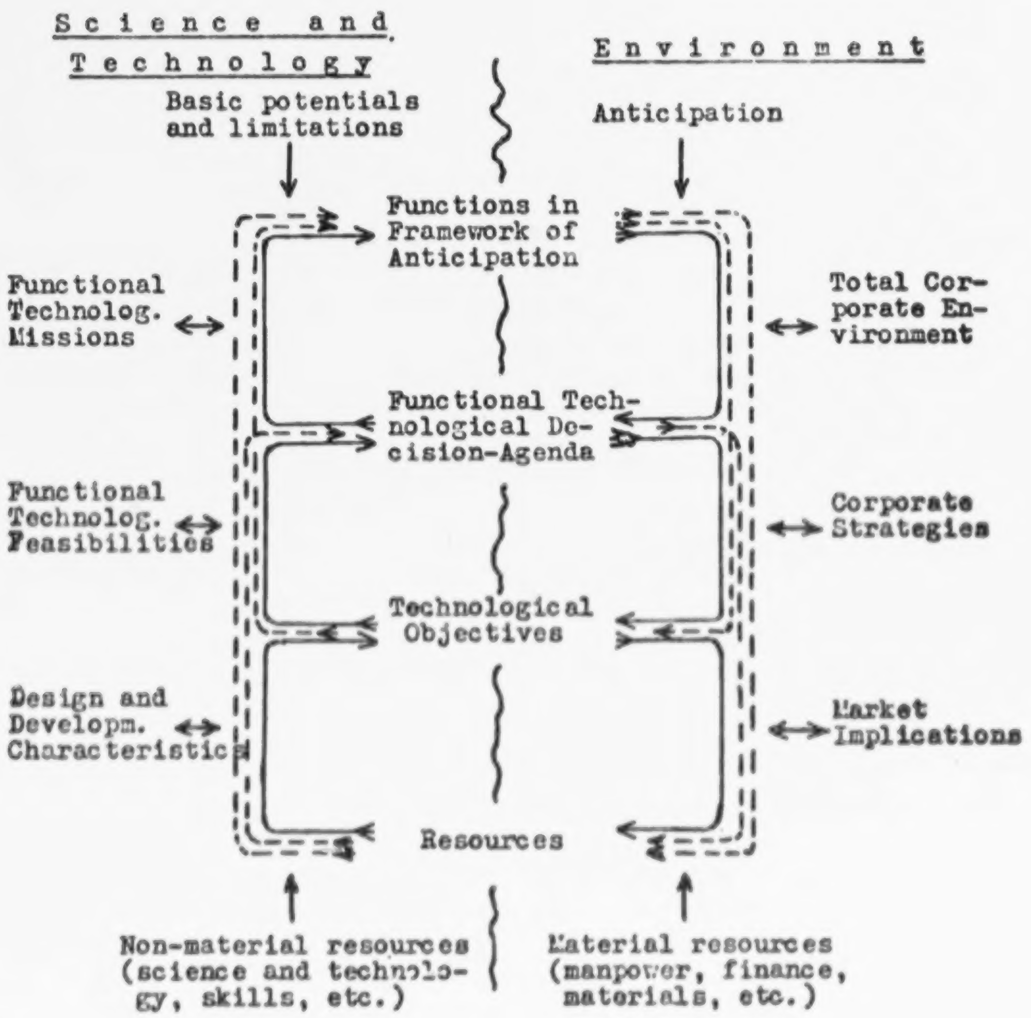
Science and Technology
Environment
Basic potentials and limitations
Anticipation
Functions in Framework of Anticipation
Functional Technolog. Missions
Total Corporate Environment
Functional Technological Decision-Agenda
Functional Technolog. Feasibilities
Corporate Strategies
Technological Objectives
Design and Developm. Characteristics
Market Implications
Resources
Non-material resources (science and technology, skills, etc.)
Material resources (manpower, finance, materials, etc.)

Fig. 5. Integrative technological planning in a corporate framework. The three main feedback loops correspond to policy, strategic, and tactical planning; the dotted lines indicate the possibility and desirability of "high coupling". Planning at every level has a system-wide scope : anticipations, functions, and technological systems, respectively. The characteristic inputs of technological forecasting are indicated for every level; on the environment side, they are enriched by inputs from non-technological forecasting.

corporate planning level, but also the triple feedback loop between technological forecasting and planning at the three corporate planning levels. Of particular importance, although less well developed as yet in terms of techniques and formal approaches, is the "high coupling" between non-adjacent levels of objectives, e.g. between the functional decision-agenda and the basic scientific and technological resources. A few companies, however, already pay particular attention to such "high coupling".

A merely tactical (operational) approach to technological forecasting and planning would focus on technological objectives and correspond to simple (linear) product line development. The combination of the tactical with the strategic approach – bringing into play the full technological decision-agenda, i.e. the full spectrum of technological options – leads to a flexible technological approach in the framework of a specific isolated function which is assumed to be rigid. But only the addition of the policy level permits the rational setting of objectives with tie-in with the goals of "ecological engineering" in a flexible framework of inter-related functions.

If we want to control the outcome of technology, we have to work back from an anticipated outcome. This is also, if we do an ideally good job, the only way to plan for consistent and reasonably stable futures. This is what we understand under *"actively shaping the future"*. Forecasting and planning provide the insight into the necessities and consequences of alternative decisions. They do not anticipate or favour a bias in the decisions.

The catalogue of available technological forecasting and planning methodology is rich in techniques pertaining to one planning level only (particularly the operational or tactical planning level, until recently the only generally recognised level), or to the interface of tactical and strategic planning (1). But it is relatively poor in techniques that attempt to span two or all three planning levels and which are of particular value for the vertical integration of technological planning. Among technological forecasting techniques (2) of the exploratory type, i.e. techniques exploring possibilities and feasibilities starting from the current basis of knowledge, morphological research (conceiving all possible combinations of the variations for the basic parameters of a concept), and scenario-writing (attempting to conceive a variety of logical steps leading to different outcomes of a specific event, such as the introduction of specific technologies, etc.) stand out. As normative technological forecasting techniques, working backwards from future objectives, the vertical relevance tree and its different numerical versions, have had remarkable success; they attempt to set up hierarchical relationships which are of particular value to relate functional to technological objectives, and, further down, to material and immaterial resources (including requirements for basic scientific and technological knowledge).

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(1) See also the elaborate model described in the paper by Robert H. Rea in this volume, which deals primarily with this interface.

(2) A comprehensive survey of techniques may be found in the author's report "Technological Forecasting in Perspective", OECD, Paris 1967.

The two most elaborate planning techniques that have been applied to the vertical integration of planning both emphasise the nature of integrative planning as planning in a time continuum, not in a rigid time-frame (1). The Planning-Programming-Budgeting System (PPBS) (2) is a scheme which makes it possible to follow dynamic programme development aimed at functional objectives. The Industrial Dynamics concept (3) permits the simulation of dynamic systems behaviour characterised by cause-effect relationships which may become visible over long time-spans only. Industrial Dynamics is a general concept which can be adapted to many types of simulation runs between resources, technologies, functions and anticipations, as depicted schematically in Figure 4.

The effective vertical integration of technological planning in an institutional, national, or international framework will depend chiefly on developments in information technology, permitting the organisation of vast input information (4), the design and storage of models of the present and the future as well as cause-effect relationships, and the simulation of large numbers of alternative courses of action. There can be little doubt that the development of information technology, in full swing now, will make this feasible to any desirable extent.

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(1) See the discussion of this particular problem in the paper by Stafford Beer in this volume.

(2) For a detailed discussion see the paper by David Novick in this volume.

(3) See the discussion of its application to the society-technology sub-system in the paper "Planning under the Dynamic Influences of Complex Social Systems" by Jay W. Forrester in this volume.

(4) For a detailed discussion of environmental information systems to aid policy planning in industrial and national frameworks, see the papers by Theodore J. Rubin and Ithiel de Sola Pool in this volume.

Looking at the *horizontal integration of technological forecasting and planning*, aiming at system-wide planning at each of the planning levels discussed above, we encounter difficulties in two directions : (a) the vast number of inter-relationships to be taken into account in large systems imposes a limit on our capacity to plan for such systems integrally ; and (b) we quickly run into difficulties concerning the measurability, i.e. the quantitative comparability, of the outcomes of technology.

Let us deal with the second problem first. It is the one which ought to be given top priority in the development of planning methodology. A useful approach has so far been developed in only a narrow sector of the society-technology sub-system, namely for defense technology, which has least to do with the " quality of life " we are attempting to plan for. This is the cost/effectiveness approach, which aims at the quantification of the effectiveness which a specific technological realisation has (or is predicted to have) in a large system, usually defined by one of the functional " program categories " of the defense system (1).

Numerous approaches exist to simple cost/benefit analysis ; they aim at quantifying the direct and predominant benefit to be derived from a planned technological realisation. These benefits may be expressed in terms of technological capabilities such as speed, strength, temperature resistance, and the like, or – as is widely done in an industrial and business context – as economic benefits, usually expressed in terms of return on investment, or – with discounted cash flow calculations taking into account the " time is money " factor – as present net value.

What is badly missing, however, is a *generalised cost/effectiveness approach in two stages* : the first stage would permit us to compare the outcomes of specific technologies within a functional system (such as " urban transportation ", where a particularly great variety of non-linear changes in the form of new technologies ought to be introduced into the horizontally integrated planning of this function). The second stage would then allow us to compare the effectiveness of plans for entire functions in relation to plans for other functions – in short, aid the effective integration of functions in the framework of anticipations. This second stage may still be relatively far off. But we can hope to develop the first stage within the next few years, if we recognise its importance.

A few modest starts have been made in this direction, for example by introducing weight factors pertaining to such elements as comfort and status in comparative studies of private and mass transport, etc. But these are relatively poor beginnings. We ought to know how much it is worth to have the air

(1) See also the paper by David Novick in this volume.

pollution level of a specific city reduced by ten, twenty, or fifty per cent, of having noise level reduced by a specific fraction, and personal mobility increased at the cost of independence. We ought even to be able to quantify such secondary phenomena as the absence of birds from polluted cities, and the variation of human life expectance with the stress imposed by urban life. There will be a wide variety of opinion on these measures of the quality of life. But we cannot hope to plan for the quality of life in other than intuitive terms if we do not attempt to define measures (which, of course, may be derived through public consensus, and refined weighting of deviations from it).

The purely economic thinking and crude cost/benefit approach is characteristic of the autonomous development of technology engineering and a belief in the sequentiality of events such as the introduction of specific technologies. It does not even look at the economic consequences of the endless technology/counter-technology sequence (1) that follows to counteract the harmful impact of technology engineering on Nature, human, and social engineering. It obstructs our view of the quality of life.

In dealing with technology in the " bi-polar " sub-systems, economic analysis becomes a part of cost/effectiveness. Desalinated water costs ought not to be compared with the costs of present natural water resources, if it is a question of making a desert habitable, or of preventing the development of arid zones where the ground water level has been lowered, or the desertion of industrialised areas which lack water for further industrial development. The unit and operating costs of non-polluting cars ought not to be compared with those of internal combustion engine cars, or the price of lead-free gasoline with that of lead-containing gasoline (a technological problem already solved, but not introduced because of slightly unfavourable economic reasons). Single Cell Protein produced on substrates such as petroleum and organic wastes, ought not to be compared with the costs of skim milk powder, which cannot solve the World Food Problem to which Single Cell Protein could make a decisive contribution. It cannot be seen, how, for example, the function-oriented Planning-Programming-Budgeting System can ever work in civilian government areas if no social cost/effectiveness technique is soon developed.

There is also a special role for governments here : adapting cost/effective solutions to an economically oriented environment, for example, by taxing the difference away so that the economic characteristics are at least equal, if not advantageous, for the socially better solution.

(1) See the paper by René J. Dubos in this volume.

The other difficulty encountered in the horizontal integration of technological forecasting and planning, namely the limitations on *system-wide planning* due to the number of inter-relationships to be taken into account, becomes visible in three ways :

(a) The number of interacting elements, and their individual variation, may be large. For example, the number of potential basic technologies and their variations may render the problem of evaluating every possible combination sizeable, or even excessive.

(b) The part of the system which is of concern for a specific planning enterprise may vary according to purpose. The "food production" function may be relatively simple for the individual farmer who has to make the choice between different plant and animal species and their combinations, but it may be much more complicated for food industry with a developed market system and it may become of hardly manageable size if seen in the light of the World Food Problem. Many of the most important functions within the society-technology and the Nature-technology sub-systems assume world-wide dimensions, and require a concerted approach of the whole world, or at least the advanced countries (1).

(c) The possibilities of non-linear change are restricted not only by the systems boundaries, but also by the inertia inherent in the various dynamic elements of the system, especially in complex social systems. We cannot change instantly either the direction or the momentum of a dynamic system – only the curvature of its movement (2). The ultimate solution of the World Food Problem (if population growth cannot be drastically influenced in the immediate future) will require the development of non-agricultural food production technology. This development has to be achieved, and introduced, between now and the year 2000. At the same time, however, agricultural productivity has to be increased by every possible means, even if it should become clear that part of agriculture will subsequently be abandoned. This type of simultaneous management, possibly assuming the character of crisis management in many functions of the society-technology and Nature-technology sub-systems, will dominate in the decades to come

As was pointed out at the beginning, the horizontal integration of technological forecasting and planning implies integrated planning of the vertical and the horizontal technology transfer, of technology and its outcome. In the future, it will mean to an ever increasing extent, the planning of systemic change (in particular, social change) through technology. This implies not only planning for new applications and new services, but also planning of entire systems involving technology, of new forms of organisation and new institutions. Computer technology provides a good example : having started with hardware development and software development (already of equal market importance) the planning tasks in this area now extend to the integral planning of organisations along with hardware and software (e.g. in management information systems), and will soon incorporate the planning of new types of institutions and inter-institutional structures. In this context, it becomes of particular importance to plan for the *rate of change* and for the introduction of technology to fit a rhythm which is in step with the systems dynamics. The methodology for achieving this task, is still in a very primitive stage.

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(1) There are private initiatives to discuss the problem of setting up joint institutes to study, and later perhaps plan jointly, such systems of world-wide concern.

(2) For a mathematical discussion of this problem, see the paper by Dennis Gabor in this volume.

Among exploratory technological forecasting techniques, contextual mapping (the time-independent synopsis of consistent systems parameter forecasts) helps in the planning of technological systems and simple functions, especially in the society-technology sub-system ; scenario-writing extends this synopsis further to outcomes and systems changes, but becomes unmanageable for more complex investigations. A certain breakthrough may be expected if the development of a " periodic table of technologies " (comparable to the Mendeleyev table of chemical elements) (1) is successful ; it would, ideally, permit the specifying of required characteristics of as yet unknown technologies and their capabilities for interaction within specific functional systems. Among normative forecasting techniques, the horizontal relevance tree (relating systems elements, including technologies and their outcomes, logically to each other in a horizontal, non-hierarchical relevance scheme) aids technological forecasting in a systems context.

Among planning techniques, systems science in its broadest meaning (comprising systems building, systems analysis, and operations research) can be applied to complex technological systems, but also – once a generalised cost/effectiveness approach has become possible – to functional systems, planning for simultaneous strategies in terms of the outcomes of technologies. As long as these outcomes are defined in simple cost/benefit terms and represent the outcomes of a multitude of sequential strategies rather than of simultaneous strategies, systems science will yield useless results. It may be hoped that we shall soon be in a position to master functional systems in the society-technology sub-system and (perhaps even before) in the Nature-technology sub-system ; the man-technology sub-system will undoubtedly prove to resist over-simplified approaches which are also hampered by the lack of knowledge in this area.

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(1) The System Development Corporation in Santa Monica, California, is at present pioneering this type of development.

Industrial Dynamics, or the art of studying complex dynamic systems incorporating a large number of built-in feed-back loops, can be extended as far as the progress of information technology and our knowledge of systems relationships permits. The latter restriction will soon yield sufficiently to study the dynamic behaviour of entire functions in the society-technology and Nature-technology sub-systems, at least in its dominating aspects. The application of simple covariance analysis (which elements reinforce, and which offset each other) will already make it possible, in many cases, to find a useful start for Industrial Dynamics, and general systems studies.

This leaves us still pretty far from the target of planning for " ecological engineering ", or for entire anticipations. However, quite a number of inroads will permit at least partial studies of dominating relationships between functions, and therefore of aspects of " possible futures ". We should still need the general cost/effectiveness approach permitting us to quantify the merits of strategies for entire functions. But, most of all, we should need much more knowledge about the relationships at work in the man-technology sub-system, from where the most dangerous threat to our naive " ecological engineering " attempts will emanate.

The task of integrative technological planning has recently been evoked and summarised by the Vice President in charge of research of the Bell Telephone Laboratories (1) : " The greatest technical innovation of the future will involve whole systems of transportation, construction, public health, agriculture, defense, communications, and so forth. The basic scientific factors that underlie the elements of the system will become ever more important... Basic science will lead us to new realms of innovations in which the life sciences, the physical sciences and the behavioral sciences will be combined in new ways of learning and in new forms of society. The time has come, with the aid of simulation and the statistical capabilities of the digital computer, to seek many more common languages and common concepts for the joint systems of man and Nature ".

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(1) Baker, William O., " Broad Base of Science ", in series Innovation : The Force Behind Man's March into the Future, *New York Times*, 8 January 1968.

THE DESIGN OF INTEGRATED TECHNOLOGICAL FORECASTING AND PLANNING SYSTEMS FOR THE ALLOCATION OF RESOURCES

by

Robert H. REA (1)

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(1) Robert H. Rea, Vice President, Abt Associates Inc., Cambridge, Massachusetts.

INTRODUCTION

The following flow chart is the model of the forecasting and planning process that will serve as the framework for discussion in this paper :

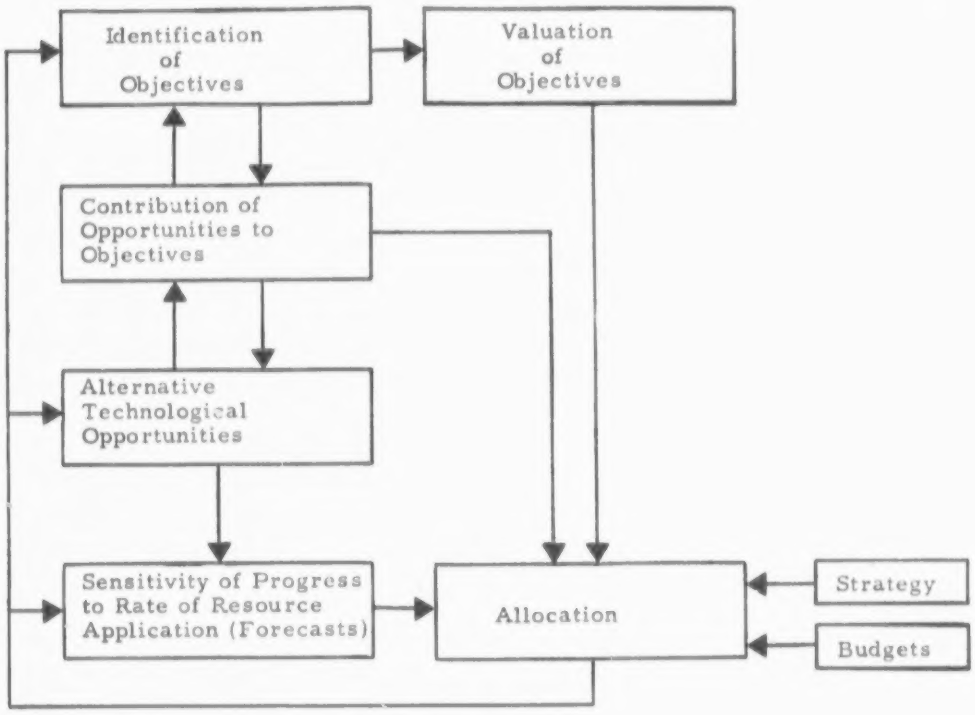
Identification of Objectives
Valuation of Objectives
Contribution of Opportunities to Objectives
Alternative Technological Opportunities
Sensitivity of Progress to Rate of Resource Application (Forecasts)
Allocation
Strategy
Budgets

Figure 1

Previous proposals have suggested that forecasting and planning should be separated, but this seems artificial because they are so highly interdependent in reality. Forecasts influence the relative importance of both actual and perceived needs, thereby establishing priorities for planning and resource allocation. In addition, separation of forecasting and planning could actually slow down the rate of technological development. When a rational resource allocator looks for forecasts that go " up " no matter what he does, his best decision would be to allocate no resources to support the development. If everyone involved in these allocations also made the " best " decisions, the curves would not go " up " at all.

Forecasts that predict advancements are absolutely dependent on a decision-maker to allocate resources to achieve the advancement, and he does it according to a plan to reach objectives in an environment of scarce resources.

There are those who would draw attention to themselves by making brash public statements about " things to come ". There are others who would write lengthy essays about the future based on their depth of intuitive insight into subtle interrelationships among complex factors, and we laud them as wise old men. Then there are those with storefronts, playing cards, tea leaves, and crystal balls who also make predictions, but they give advice on what one should *do now* about the future. These efforts (except for the last one) are conducted at a sufficiently aggregated level of detail that they offer little help to resource allocators. This situation brings up the issues that must be faced if forecasting and planning for resource allocation is to be useful to decision-makers.

These issues are the interrelated trade-offs among scope vs. depth and methodology vs. substance. Future political scenarios written by some have great scope and some substance but very little depth and quite simple structure. Conversely, such problems as deciding among alternative projects to provide electrical power sources for automobiles that are well beyond current capabilities require considerable substantive depth, but they rarely consider the full range of economic and social implication.

In both of these very different situations there is substantive information available at many levels of detail, and there are methods for handling the information within a single level of detail. The thing which is missing that could lend very powerful assistance is *methodology to span the levels of detail.* The development of this methodology is a major task for forecasters and planners.

Its development could make the essays of the predictors relevant to resource allocators in many sectors. It could make scientific and technological research and development alternatives relevant to the strategic concerns of top level management of both private corporations and government agencies.

There is much to be done. The literature is full of and planning offices are empty of analytical tools that could be assembled to span levels of detail. The bottleneck that has retarded their use is skepticism that the appropriate information could be assembled and handled properly. However, it is now possible for any corporation or government agency to be advised on the " best " choice of technological development projects that it should make to exercise the greatest possible influence in the competitive environment of the future – given enough effort. The problem is thus reduced to deciding how much effort is appropriate.

The remainder of the paper will describe some analytical tools that can be used to perform the functions required in an integrated forecasting, planning and resource allocation system. It will continue with the presentation of some of the problems that have been encountered and some of the opportunities that have been revealed during the process of designing and implementing forecasting and planning systems. It will conclude with proposals for more advanced systems and suggestions for further research.

ALTERNATIVE SYSTEMS

The general approach to the design of forecasting and planning systems is 1) to identify the functions that must be carried out in the resource allocation process, 2) to search for analytical tools that can be employed to carry out these functions, 3) to analyze the inputs, outputs, benefits, and costs of each tool, 4) to evaluate their requirements and performance in terms of established criteria, and 5) to choose the best combination of tools to form the system. The following paragraphs will discuss each of these steps, using the flow chart given above to represent the process.

The previous flow chart identifies the following functions that must be performed by a forecasting, planning, and resource allocation system for a given environment :

1) Identification and Valuation of Objectives
2) Contribution of Opportunities to Objectives
3) Sensitivity of Progress to Rate of Resource Application (Forecasts)
4) Strategy
5) Resource Allocation Algorithm

Each of these functions can be satisfied by a variety of techniques ranging from the relatively simple to the highly complex. Simplicity and complexity are differentiated on the basis of the degree of subjectivity of the inputs required to operate the system. All systems must resort to unstructured subjective judgments at some point, and one system is considered more complex than another one if it relies more heavily on data based on detailed engineering parameters than based on relative value expressions of decision-makers. It turns out, not surprisingly, that the greater the level of complexity, the higher the cost of using the tool.

The situation is one of having tools available that provide increasing benefits and increasing costs. The problem is to select a system that can provide useful results that do not cost a significant percentage of the resources that are being allocated. It is all too easy to become fascinated with the possibilities of the system and slowly lose sight of the original purpose. One is reminded of the tacitly understood rule that the number of employees in the United States Department of Agriculture should not exceed the number of farmers.

Technological advancement proceeds through a sequence of phases that can be represented by the diagram on the following page, developed by Erich Jantsch (1). Both forecasting and planning processes are necessary throughout the various phases, and they all involve the functions described on the previous page. However, the kinds of variables used markedly changes from phase to phase.

For example, the objectives of exploratory scientific research in the Pre-Discovery and Discovery Phases might be to address questions of current research interest. The questions might be valued in terms of the impact that their answers might have in the scientific community. Alternative research projects could be proposed in terms of the likelihood of their answering the questions and their cost in funds, facilities, and skilled manpower. Strategies might include trade-offs of seeking large changes with low probabilities or small changes with high probabilities, and projects could be selected on the basis of benefits, derived from the factors, and costs constrained by available resources. When unexpected discoveries appear, new questions can be asked and new projects can be formulated within the same framework.

In the Engineering Phases the variables used might be those of the new product planning processes, such as projections of market size, the share of the market that might be captured by alternative products with different characteristics and development times, strategies of timing and advertising, etc...

Decision models for performing the planning function in the Engineering Phases are well-known and used routinely. Tools for the Discovery Phases are just beginning to be developed. A large part of the remainder of the paper will focus on the design of models as aids to decision-making in the Substantiation Phase, including the interfaces with Creation and Development. Then models can be of immediate utility to industrial and government enterprises that must

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(1) Jantsch, Erich, " Technological Forecasting in Corporate Planning ", Paper presented at the Conference on Technological Forecasting, 18-22 March, 1968, Washington, D.C. Fig.4.

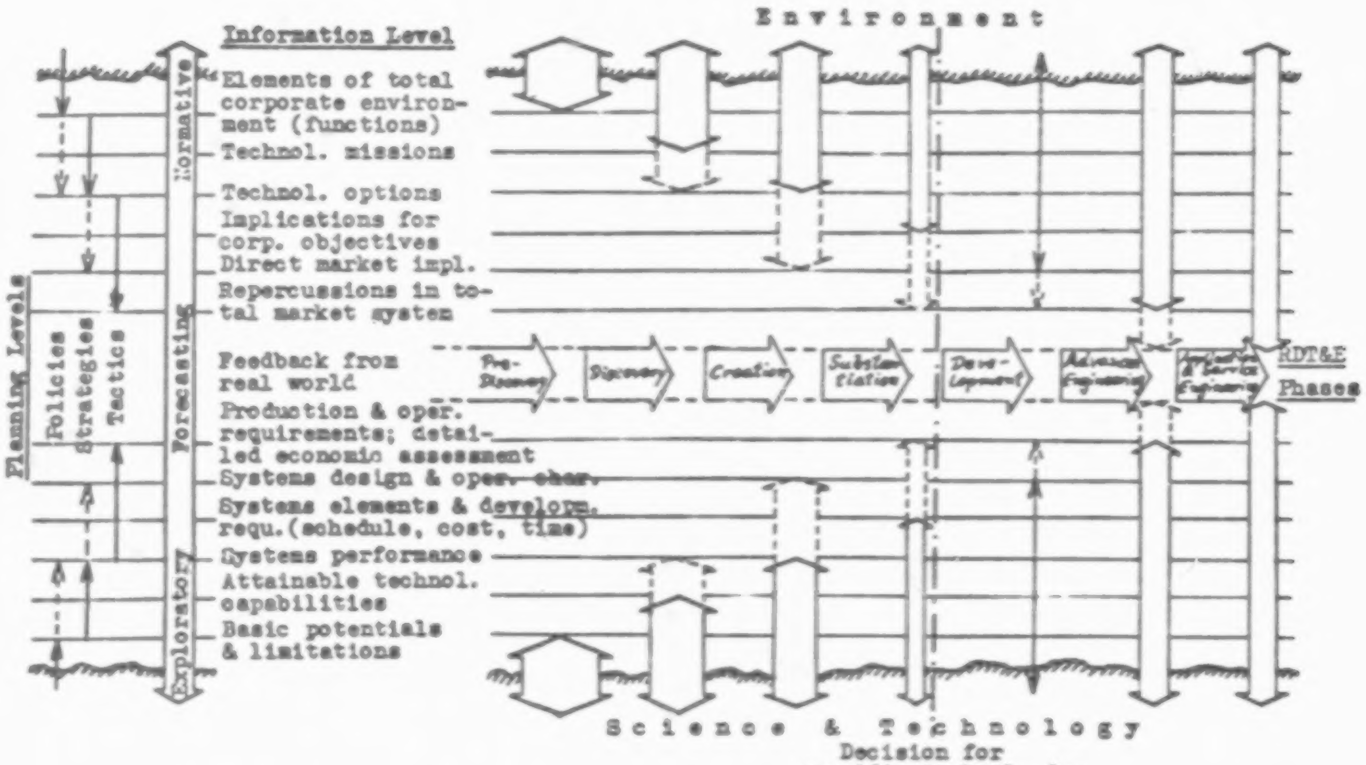

Environment
Planning Levels
Policies
Strategies
Tactics
Normative
Forecasting
Exploratory
Information Level
Elements of total corporate environment (functions)
Technol. missions
Technol. options
Implications for corp. objectives
Direct market impl.
Repercussions in total market system
Feedback from real world
Production & oper. requirements; detailed economic assessment
Systems design & oper. char.
Systems elements & developm. requ. (schedule, cost, time)
Systems performance
Attainable technol. capabilities
Basic potentials & limitations
Pre-Discovery
Discovery
Creation
Substantiation
Development
Advanced Engineering
Application & Service Engineering
RDT&E Phases
Science & Technology
Decision for specific technol. dev.

Fig. 2. Technological forecasting stages in relation to the RDT&E phases of a typical technological innovation. The formal scope of each technological forecasting stage is the forecasting of the outcome of the next RDT&E phase, the informal scope (dotted arrows) extends further. Six forecasting stages and one evaluation stage may be distinguished. The thickness of the arrows indicates schematically the width of forecasting, narrowing down in the course of vertical technology transfer from the simultaneous consideration of a large number of alternatives to the decision for one specific development line, and subsequently widening again in considering alternatives of horizontal technology transfer (applications and services).

face the difficult decision problems presented by rapid innovation. The paper will conclude with brief suggestions and questions for further research into analogous models in other planning stages.

The following chart lists the required functions shown on the flowchart and some examples of tools of increasing complexity (left to right) that could be used to perform the functions. They are identified by paragraph numbers that follow and which contain brief descriptions, input and output requirements and statements of benefits and costs.

<table>
<tr><th>Alternatives →
Functions ↓</th><th></th><th colspan="2"></th><th colspan="2"></th></tr>
<tr><td>Valuation of Objectives, and Programs 1.</td><td>Subjective Matrices 1.1</td><td colspan="2">Internally Consistent Subjective Matrices 1.2</td><td colspan="2">Complex Mathematical Models 1.3</td></tr>
<tr><td>Contribution of Opportunities to Objectives 2.</td><td>Subjective Scale 2.1</td><td colspan="2">Simple Network 2.2</td><td colspan="2">Mathematical Models 2.3</td></tr>
<tr><td>Sensitivity of Progress to Rate of Resource Application (forecasts) 3.</td><td>Single Schedules 3.1</td><td colspan="2">Completion Dates, Variable & Cost Schedules 3.2</td><td colspan="2">Probabilistic Elements 3.3</td></tr>
<tr><td>Strategy 4.</td><td>Intuitive 4.1</td><td colspan="2">Standard 4.2</td><td colspan="2">Decision Trees and Utility Functions 4.3</td></tr>
<tr><td rowspan="4">Resource Allocation 5.</td><td rowspan="4">Yes-No 5.2</td><td colspan="4">MATHEMATICAL OPTIMIZATION</td></tr>
<tr><td>5.2</td><td>Linear Prog.</td><td>Dynamic Prog.</td><td>Optimal Cntrl</td></tr>
<tr><td>Max. Value</td><td>5.2.1</td><td>5.2.2</td><td>5.2.3</td></tr>
<tr><td colspan="4">Min. Cost</td></tr>
</table>

1. Valuation of Objectives and Programs

The methods of evaluating objectives and programs vary widely according to specific application. These differences are the greatest between government and industry. Government agencies are established for specified purposes, and statements of objectives are easy to find, although difficult to translate into relative values of programs. The discussion of the alternatives that follow is more suited to government programs.

Industrial valuation depends on corporate objectives and the needs of potential consumers. The concerns of marketing (at the tactical level) are those of responding to these needs by offering products that can satisfy them. The issues are those of identifying the dimensions along which consumer preferences and perceptions are relevant and measurable, and comparing them with similar dimensions of potential product performance. Comparisons of these factors can be used as a basis for valuation of objectives, where " success " can be expressed in terms of sales, market share, and profitability.

1.1 Subjective Matrices (1)

A series of subjective matrices that translate objectives and their relative values into relative values of proposed programs, where programs are defined as alternatives to achieve the objectives, can be used to support the function of valuation. The *input* requirement of these matrices is a carefully defined set of objectives and program alternatives, along with expressions of relative value defined by individual decision-makers. The *output* of these matrices is a set of relative value assignments to each of the program alternatives arrived at by summing the products of program contributions to objectives and the values of the objectives. The *benefits* of this approach are explicit statements about objectives and programs with a capability to observe the changes in individual program values as a function of changes in any of the values used to arrive at the final value.

The *costs* of this approach are the time required to arrive at an acceptable and agreed upon set of categories for the series of matrices, the time required to identify the proper decision-makers to fill them out, the time actually spent in filling them out and the time spent in obtaining agreement about the way they were filled out.

1.2 Internally Consistent Subjective Matrices

The application of the constraint imposed by requiring internal consistency among the values of elements in the matrix can reduce the arbitrariness of the

(1) Both matrices and relevance trees are considered to be special cases of hierarchial structuring.

values assigned. One interval scaling technique that can be used here is the Churchman-Ackoff (1) approximate measure of value procedure. The *inputs* required in this case are the same, but in addition the descriptions for the following procedures for insuring internal consistency must be included. The *output* is in the same format, i.e., relative values of program alternatives. However, confidence is increased in the relative values due to the requirement for internal consistency. The *benefits* are the same as before except that additional time is required on the part of the decision-makers to follow the procedures required to insure internal consistency. This time might be estimated as approximately three times that required for the previous activity.

1.3.Mathematical Models

The previous two methods relied on subjective estimates of the relative abilities of alternative programs to achieve objectives. If the program elements can be described in terms of detailed quantitative engineering performance indices, then mathematical models of the various program alternatives can be used to generate similar indices with the values corresponding to the ability of each of the program alternatives to obtain the level of performance specified by the objectives. In this case the relative contribution of individual programs can be determined by comparing them individually to the level of performance required by satisfaction of the objectives. Some subjective value judgments based on scaling would still be required as input ; however, they would be restricted to the level of assessing the relative importance of the objectives to be achieved. The use of mathematical models would shift the uncertainties involved from the arbitrariness of value assignment with subjective scaling to the validity of the predictive theory elements and the plausible range of variable values used. The *input* required in this case, would be the identification of the engineering parameters and their interrelationships which would describe the program's performance and the level of acceptable performance that is necessary for the program to meet the objectives. In addition, mathematical models of the performance of the alternative programs would have to be designed and operated in order to find out what values of these parameters could be realized by the competing programs. The *output* from this approach to valuation is still a set of relative values of individual program alternatives. However, in this case they would be based on less subjective parameters. The benefits of this approach permit much greater variation of detailed parameters to determine the sensitivity of the relative program values. In addition, they provide less subjectivity in value assignment. The *costs* are substantially greater than the previously described matrices because of the necessity to include some mathematical modeling work to handle various program parameters.

(1) Ackoff, Russell L., *Scientific Method, Optimizing Applied Research Decisions,* John Wiley & Sons, New York and London, 1962, p.87.

2. Contribution of Opportunities to Objectives

The value to be assigned to a project, where "projects" support "programs" that achieve "objectives" is a function of its *contribution to* the programs. For certain government military and space programs, it is desirable that the project be completed when it is required for use. If it is completed much later than the date desired for starting a program then it cannot be used without incurring delays. If its development time is sooner than that required for individual programs, then the opportunity costs of supporting during that time period other projects that support other programs, makes the early attainment of project results an inefficient activity. This philosophy is not the same as the assignment of value to R & D projects found in industrial programs for commercial ventures. In these areas, the concept of short term project evaluation by discounted present value and internal rate of return, pay-back period, and return on investment is used. These measures result in a bias to obtain returns as quickly as possible because the uncertainties of long term payoffs preclude the assignment of benefits that are large enough (when compared with short term pay-off projects) to offset the compounding effects of discount rates. However, in the case of organizations with specific requirements for project completion at a specific point in time to start a program, the concept of completing the project as soon as possible is not appropriate.

2.1. Subjective Scale

One way to estimate the contribution of a project to a program is simply to assign a subjectively derived value on a scale of say, 1 to 10, where 10 might be an essential contribution and 1 might be a marginal improvement in program performance. The *input* required to arrive at this assessment would be a list of programs and their descriptions and a list of projects and their descriptions. These two lists combined with a descriptive scale can be used by both the project experts and program experts to arrive at final values for contributions. The *output* of this activity is a list of the projects that are competing for funds and their subjectively derived contributions to each of the programs. The *benefit* of such an approach is its simplicity. It also fosters better communications between program-oriented experts and project-oriented experts in that it provides an opportunity for discussion of the role of each project in each program. This transition from discipline to function orientation is both difficult and necessary. The *costs* associated with this method are the time required to develop lists of programs and projects for these evaluations, the time required to find decision-makers who are appropriate to make the judgments, and the time required for them to reach agreement on what the values ought to be. Incidentally, an allocation mechanism based on these kinds of inputs cannot insure that any program will be completely supported. It simply provides a bias in the allocation process for projects that make large contributions to important programs.

2.2 Simple Network

The major components of program descriptions usually can be identified and developed into a network consisting of these components in series combined with the various project alternatives within each of the major components in parallel. In this case, if probabilities of project completion can be assigned to each of the elements in this network, then the total probability of initiating programs at the desired date can be calculated. The *inputs* required for such a network are : a list of programs, their major components, and a list of project alternatives within each component. In addition, the probabilities of each of the projects being completed by the desired date is required. The *output* in this case is a determination of how program probabilities change as a function of changes in individual project probabilities. The *benefits* of these networks include the assessment of project contributions to individual programs on a much less subjective basis than the scale discussed in paragraph 2.1. In addition the contribution of an individual project to a program may be determined directly by observing how the overall program probability changes as a result of including the project or not. Such a network may also be used directly in an allocation process whose objective might be to maximize the probability of starting all programs at the desired dates. The *costs* of developing such networks would be an identification of the components of various programs, reporting project data in terms of contributions to programs, and the time of collecting and preparing the data for input to an allocation program.

2.3 Mathematical Models

Since the mathematical models discussed in paragraph 1.3 would necessarily include a network representation of individual programs within the model itself, it would also serve the purpose of determining project contributions. This would require no additional *inputs*. Additional *outputs* would be individual project contributions to each of the programs. This output could be considered an additional *benefit* and there would be no additional *costs* required other than those already attributed to the model.

3. Sensitivity of Progress to Rate of Resource Application (Forecasts)

The technological forecasting inputs enter the process in this function, and explicit linking of forecasts with resources is required. The familiar problems of selecting proper indicators of progress are encountered, but the problem is somewhat more constrained than that of forecasting without resource considerations because *there is no need to extrapolate the progress indicator beyond our ability to conceptualize research and development projects that could cause its advancement.* Extrapolation methods based on faith and a keen sense of history that shows that breakthroughs are bound to come along because they are needed are useful imagination-stretching exercises. The results of such activities can and surely will influence final decisions, but they are not needed for decision models beyond the Substantiation Phase. Lead times between R & D and application in technology-based industries are sufficiently long so that decisions made today would probably not be changed significantly because of knowledge of potential performance beyond currently conceivable projects. When information about impending breakthroughs becomes available, it can easily be incorporated into the system because, at that point, it is conceivable. Implications for major change derived from the analysis of available concepts should be sufficiently disruptive so that adding further confusion with shaky speculations would not be very helpful.

3.1. Single Schedules

Project progress, costs and time can be reported as a single schedule of costs over time, resulting in a stated completion date. The *inputs* for this function are simply the completion date and yearly costs. The *output* is the same. The *benefits* derived are simply the information presented and the *costs* of obtaining information are simply the time required to generate it.

3.2 Variable Completion Dates and Cost Schedules

Rather than a single schedule, the completion dates for each project can be expressed as a function of the rate of resource application. The *inputs* for this function are the range of completion dates and the resource schedules that correspond to each date. Since this is an information item, the *output* is the same. The *benefits* are the possibility of either accelerating this rate or slowing it down, in addition to selecting the single option available in 3.1. This can be done with a better knowledge of the sensitivity of the project completion date to the rate of resource application. The *cost* of obtaining the information is the additional time required to provide the data.

3.3 Probabilistic Elements

None of the basic elements of project progress, cost, and time are deterministic ; they are all uncertain to varying degrees. These uncertainties are interdependent. In a typical research and development program, what one does next is quite dependent on the outcome of what one is doing now. However, if " if-then " statements can be made, it is conceivable that one would be able to assign relative probabilities to outcomes, given a certain outcome of the previous step. There are ways of dealing with these uncertainties analytically, known as the application of decision theory to problems of uncertainty. Estimates of uncertainties can be made in an orderly way so that one can have an indication of the level of confidence that is appropriate for specific results. The *inputs* that are required to achieve such clarity include the following : 1) an enumeration of " if-then " statements that describe the project, 2) what action would be taken if a certain outcome were assumed,

3) the probabilities of attaining each of the outcomes, 4) a maximum, minimum, and expected times of completions of individual tasks, and 5) corresponding estimates for costs for each of the tasks. The *output* would be expected progress over time, the time required to complete a project, and the costs that could be expected over the time periods, along with measures of the degree of confidence that is appropriate for each of the estimates. The *benefits* are the production of results with explicit consideration of the uncertainties. The *costs* of this activity are primarily those of time spent in making the estimates of the possible eventualities that could occur. At this point, the opportunity cost of planning instead of actually doing the work becomes a significant item because of the substantial amount of time required to produce these data.

4. Strategy

The function of strategy formulation is required when the Environment Definition function presents more than one situation to be planned for and project values vary with each scenario. When this is the case, methods for handling multiple contingencies must be used.

The environment seen by the strategist is a competitive one, and he should consider as many plausible positions that he might assume relative to his competitors. It is rarely appropriate and usually not necessary to invoke the mathematics of game theory, but is necessary to estimate relative pay-offs over a range of plausible situations.

4.1 Intuitive

The *input* for the intuition alternative is a table of project pay-offs for each contingency. A decision-maker runs his eyes over the table and his *output* is a table of relative values of all of the projects. The *benefit* is derived from preparing this pay-off table and presenting it to the decision-maker in a form that permits him to see how pay-offs change with different scenarios. The *cost* is the time spent in preparing the tables.

4.2 Standard

There are standard strategies available for use under uncertainty where decisions must be made among a set of outcomes with unknown probabilities. Some examples are :

A. Minimax : Make the best of the worst possible situation by ordering projects in descending order of their smallest pay-offs.

B. Maximax : shoot for the greatest possible pay-off even though it may be risky by ordering projects in descending order of their greatest pay-off.

C. Minimax regret : order projects in the inverse order of the regret that might be realized, defined as the largest difference for all contingencies between a project pay-off and the largest pay-off of any other project in a single contingency.

The *input* required is the same project pay-off table required in 4.1 for each scenario and the *output* is the same table of project relative values. The *benefit* derived is the ability to see how project values change as different strategies are considered. The *cost* is the additional time required to produce the different relative value ranking from the pay-off tables.

4.3 Decision Trees and Utility Functions

Both decision trees and utility functions can be useful for strategy formulation under risk, where outcomes with "known" probabilities can be estimated. The decision tree process makes an effort to enumerate the consequences of all possible actions, their probabilities, and their utilities or pay-offs. With this information at hand, straightforward expected value calculations can be made to recommend a course of action.

Utility functions can also be constructed for an individual decision maker to structure his preferences over risky alternatives. These preferences can be constructed by asking him questions about his choices among gambles. The structural risk propensities can then be used (very carefully) to predict his preferences in real world situations.

The *inputs* required for these methods are enumerations of possible consequences of actions, their probabilities, and pay-offs, and carefully structured procedures for utility function construction. *Outputs* are relative values of proposed projects that have risk taken into account. The primary *benefits* are derived from laying out the alternatives available and going through the analysis required to produce probabilities and pay-offs. The output can also be used directly in the resource allocation function. The primary *costs* are those of a considerable amount of time by skilled professionals that could be used in other work.

5. Resource Allocation

5.1 Yes-no

Given measures of relative values and costs for all of the projects under consideration, the benefit-cost ratio for a project can be formed, and the projects can be selected in order of decreasing value of the ratio until the required funds match the expected budget. The *inputs* required for this function are the relative values for each project under consideration, and their expected costs. The *output* is a list of selected projects and a list of unselected projects. The *benefit* of this technique is that it is straightforward and inexpensive. It does place competing projects in a kind of priority order and permits some sensitivity analysis. However, one of the disadvantages of this technique and hence a *cost* to achieving effective planning is the fact that partial funding of projects is not permitted and the necessary yearly distribution of resources among all of the selected projects is not done.

The implications for future program success are also not clear, because in some cases there will be essential projects that are not scheduled for funding.

5.2 Mathematical Optimization

Within this alternative to the resource allocation function three options of varying levels of sophistication and computational complexity are discussed below.

5.2.1. Feasible Solutions by Linear Programming (L.P.)

The general forecasting and planning problem is characterized by nonlinearities such as project responses to effort and offset program initiation dates. Thus a first attempt at its solution is to extract what *is* linear and see how much information can be gleaned from that simplification.

This approach involves no optimization. Rather it is a way of finding a *feasible* pattern of expenditures. There is no selection of projects, no varying of the amounts of funds they are to receive, and no recognition of the probabilistic nature of project completion. Specifically, the three *inputs* to this approach are :

1. The set of projects to be funded and the total amount of support each will need over the planning period.
2. A list of the programs that will use each project and the initiation date of each program.
3. The period-by-period budget that is to be allocated among the projects.

The *benefits* of linear programming are :

1. Very little computer programming is required. Only slight modifications to general purpose linear programming codes are needed.
2. It provides as *output* reasonable way to support all projects so that they are ready when needed while staying within the overall budget.

The *costs* of this approach are :

1. It requires much decision-making to have been completed. Specifically, exact projects and their total budget requirements must have been selected previously.
2. Several factors are neglected : the current capabilities in certain project areas, the varying responses of different projects to expenditures, and the complementary and substitute roles of some projects in various programs.

5.2.2. Suboptimization with Dynamic Programming (D.P.)

Since this problem has a strong multi-stage character (decisions in one period affect the options available in the following period) it is natural to attempt to use the technique that was originally designed for such problems – dynamic programming. However, large numbers of projects, each of which must be represented by a state variable, make a truly optimal dynamic program computationally infeasible. However, there seems to be considerable value to finding a suboptimal solution, i.e., one that is good but not necessarily the best.

By looking at only one period at a time, we can use only a single state variable (the amount of budget available for that period). In comparing this approach to linear programming, the following points are important :

1. No general dynamic programming computer codes are available (as LP codes are) so that this must be done from the ground up. However, the recursion relations are not complicated and the use of FORTRAN or PL/1 can facilitate this part. Moreover, some reprogramming must be done even for LP so that, in total, the DP programming requirements are only slightly more demanding than the LP requirements.
2. By its period-to-period nature, DP may produce uneven patterns of project expenditures whereas (by using restricted entry) LP can assure that once a project receives any funds, it will continue to receive funding in each succeeding period until it is completed.
3. Within each period, DP takes account of the varying levels of completion and rates of response of each project, whereas LP requires that these factors have already been considered in selecting the fixed set of projects to be done.
4. DP does provide some optimization while LP just searches for feasibility.

5.2.3. Total Optimization by Optimal Control

It appears that the only way to consider all factors simultaneously – probabilistic completion dates, project response rates, offset program initiation dates, variable project budgets, etc. – is to cast the problem into the framework of optimal control. It is not surprising that this approach bears the greatest computational burden. The programming must be done from scratch, convergence by the algorithm must be demonstrated, and the number of control variables is far greater than examples appearing in the current literature. Against these limitations are set the following advantages :

1. The output is the totally optimal solution to the entire program : it selects a set of projects for each program and allocates fund to them within the budget limitations while taking account of program deadlines and the varying contributions of each project to different programs. Thus it is not limited by the period-by-period myopia of DP or the preselected set of projects and their budgets of LP.

2. The dual variables (or shadow prices) corresponding to the optimal solution pinpoint those areas (represented by budget of project-dynamic constraints) which would have the greatest impact on improving the objective function. This could be especially valuable for contingency planning to see what projects could be supported if the total budgets were to change in the future.

Feedback

The results of the resource allocation process is a list of projects and the best schedule of resource expenditures that can be found within the constraints and objectives defined. With the expected project outcomes given, an assessment can be made of the degree to which the objectives might be achieved and can also suggest which objectives might better be abandoned. It is at this point where planning begins. The planner now has a big " if-then " machine at his disposal, and he can change the value of any input variable, make orderly sensitivity tests, and even use built-in decision rules for adaptive convergence.

5.3 Optimization Criteria

An additional specification must be made for the programming option that is finally selected. The programs may be designed either (a) to maximize an expected value function within the constraints of specified budgets or (b) to minimize costs to achieve specified performance objectives.

The *input* requirements for "maximizing effectiveness" are the statements about relative program values, the contributions of various projects to the programs, the data about the timeliness of project completion relative to desired program achievements, the yearly cost of projects, and specification of annual projects and their yearly level of support, and an explicit indication of the degree of support offered by the projects to each of the programs. The major *benefit* of this option is the ability to input expected annual budgets. The *costs* of disadvantages of this technique are the requirements for making statements about relative values of program and project contributions to each program.

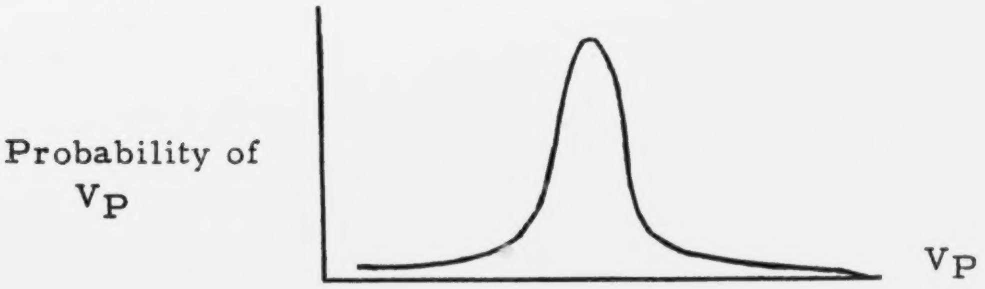
For the case of minimizing costs to obtain a specified level of performance, the *inputs* are the yearly costs of the project candidates, measures of project performance, and requirements to be met by the total development program. The major *output* of this option is the yearly budget required to provide the stated level of performance. The *benefit* of this option is the lack of the requirement to assign relative values to programs. The primary cost or disadvantage to this approach is the necessity to change various values so that the yearly requirements for resources will in some way come close to the yearly level of resources which realistically can be expected.

This completes the discussion of analytical tools that can be used to perform the functions required by a forecasting and planning system. Before continuing to discuss the selection of tools to form a system, a point about explicit handling of uncertainty needs to be made.

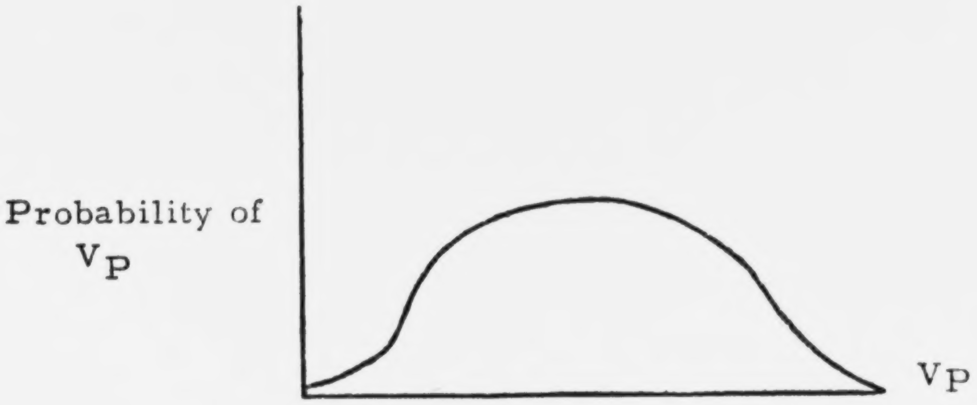
Effects of Uncertainty in Estimating Values of Parameters

Whenever a quantitative approach is chosen to satisfy a function of the planning process , values must be assigned to the relevant parameters. For each of the quantitative alternatives discussed above, it has been assumed that each of these parameters has a single value. However, it is seldom, if ever, the case that the parameters' values (Vp) are known with such precision. Instead, each parameter has a probability distribution associated with its estimation.

For those parameters which can be estimated with a high degree of accuracy, this probability distribution is of the form:



For other parameters, it is more difficult to estimate values. The probability distribution for these parameters is of this form:



The greater variance (or spread) of the probability distribution reflects greater uncertainty about the true value. While this is not to imply that these parameters *are* random variables, it does say that our knowledge of them is such that we should allow deviations away from their central values.

The implications for exact treatments of such refinements are not encouraging. While the optimization problems under certainty may be merely thorny, the same problems with variations permitted may be wholly intractable. Even in such well-developed textbook problems as the transportation linear program, the introduction of uncertainties changes the whole treatment to a nonlinear programming problem. There are two basic approaches to dealing with these uncertainties.

First, one could find the *expected values* of each parameter from their distributions and use these *as if* they were the true values. When the variances are small this approach will yield a reasonably good solution for the decision variables, and the value of the objective function will provide an upper bound for its precise expected value.

Alternately, one may select several values from the allowable ranges and solve the problem repeatedly using different combinations of these values. This will provide evidence of the sensitivity of the optimal solutions to parameter changes. It is not unusual that some subset of parameters can vary quite widely without having appreciable effects. One can then concentrate on finding more exact knowledge about the parameters in this crucial set instead of spreading one's energies over the whole field.

SELECTION OF ALTERNATIVES TO FORM COMPOSITE SYSTEMS

Having examined alternative techniques for satisfying each function of the technology planning process, consideration can now focus on selecting an integrated forecasting, planning and resource allocation system. A fundamental requirement of the selection is that a single alternative must be chosen from each functional category. To assure an integrated system, however, it is also necessary that the set of alternatives chosen be internally consistent. That is, their input and output data must be compatible.

Presenting alternatives is not enough. Criteria for selection must be defined and used. Hopefully, some of the more quantitative methods discussed for project selection can be employed to select the integrated system. Demonstration of quantitative methods of comparing performance alternatives with criteria and system selection must wait for a specific application. However, since this operation is such a crucial one, a qualitative discussion will be presented of some of the trade-offs among the previously discussed function alternatives that should be taken into account.

Selection among alternatives, for example, could be made on the basis of the following criteria :

1. Level of confidence or uncertainty that can be assigned to the variables.
2. The kinds of variables used, i.e., subjective values or engineering parameters.
3. The number of variables and their interactions considered (level of detail).

The following paragraphs discuss the comparisons of alternatives in each functional category. Additional criteria are introduced to aid in defining commensurable characteristics for more direct comparisons. The criteria elements are identified by underlining.

Valuation of Objectives and Programs

Adding the requirement for internal consistency substantially reduces the ease with which the subjective matrix elements can be changed without disrupting the entire value structure. In this sense, substantially more *confidence* can be attributed to consistent elements. Although mathematical models deal with engineering parameters, there is still a considerable amount of uncertainty in their values and the logic that ties them together.

It is more desirable to use engineering parameters than subjective values for mission valuation. Mathematical modeling does allow the use of these parameters for a portion of the valuation task. The model can evaluate the contributions that different program configurations can make to specific objectives. However, the assessment of the relative values of objectives is still left to subjective evaluation.

On a unit time basis, the consistent matrix procedure cannot handle as many variables and interactions as matrices without the use of consistency procedures. It would require of the order of three times as long to relate the same number of variables. However, this does not become excessive unless the number that can be handled is less than the minimum number required.

Contribution of Opportunities to Objectives

Determining technological contributions of individual projects to programs involves comparisons between performance required by the programs and performance available from the projects. Since these values are being compared for the same time period in the future, similar levels of *confidence* can be assigned to each. Overall program performance requirements can be stated with greater confidence, but one can be no more confident in choosing program element performance requirements from the trade-offs available than in projecting project outcomes that support program element performance, since they are interdependent.

The confidence comparisons must be made on the basis of two aspects of the problem. One is for the purpose of evaluating individual projects. The other is for evaluating the changes in overall program performance as changes are made in the performance of its elements.

The project alternatives available determine the contributions at various levels of confidence and cost. The subjective scale is more useful for assigning values to projects than for determining program performance sensitivities. However, the final values assigned should be the result of agreements between project and program planners as to the proper numbers to be assigned. The subjective scale does not provide explicit information on program performance sensitivities. However, inferences can be drawn by analyzing a list of projects that contributed to individual programs and comparing available and required program element performance. Although there are problems with the subjective scale, it does provide some relevant information at low cost.

The simple network can produce explicit information on both project value and program sensitivity. The major difference between the network and the model is in the *level of detail* considered. The network uses highly aggregated data and is, therefore, less precise.

Sensitivity of Progress to Rate of Resource Application

The probabilistic elements alternative directly addresses the *level of confidence* that can be assigned to the variables. Explicit provisions can be made for estimating the uncertainties inherent in projections of progress, cost, and time. However, the time required to consider all of the variables and their interactions is greater than the time available. Even if this were done, there is currently no resource allocation algorithm that could handle the data properly. The two remaining alternatives, though deterministic, can shed some light on the impact of various levels of confidence through systematic variation of variable values within their ranges of uncertainty.

Slightly greater confidence can be had in variable completion dates and cost schedules than single schedules because of the necessity to consider the changes in rate of progress as resource levels are changed. However, the *kinds* of *variables* are the same, i.e., completion dates and dollars.

There would be several times as *many variables* and interactions involved in variable completion dates than single schedules, but the additional information that they provide allows substantially more flexibility in planning.

Resource Allocation

The choice of a resource allocation system has been discussed in paragraph 5 above. However, the simple benefit-cost ratio has very limited value because it cannot discriminate yearly allocations and does not provide for partial support of projects.

The operational characteristics of the several mathematical programming techniques that are available are dependent on the nature of the data and computing facilities available.

Choice

The previous discussion has covered benefits and costs of alternatives and their comparisons. Before the final choice can be made, both relative and absolute costs of the systems that could be assembled from the components must be estimated. Hopefully, a system can be found that will provide satisfactory performance at a cost that is a reasonably small percentage of the resources being planned for.

* * *

Although it was somewhat laborious to go through a generalized example, the functions described are a complete list, and the alternatives presented are a significant percentage of the techniques available. Therefore, the framework presented represents a substantial foundation on which to build integrated forecasting, planning, and resource allocation systems for many specific applications.

A few specific applications have been made, and many questions can be raised. The following section will address some of the questions and mention some of the applications.

QUESTIONS AND APPLICATIONS

The system described in the previous section appears to be suited best to *normative strategic* forecasting and planning for both the *environment* and *science* and *technology* in the *Substantiation* phase, including the *Creation* and *Development* interfaces. However, even though the system seems to be objectives oriented, the forecasting function permits experimentation with any idea or concept that might arise in science and technology from an exploratory process and provides an opportunity for evaluation, once the environment impact had been checked to see what implications for change were contained in the new idea. Because of this interactive process, implications for changes in both the environment and science and technology must be considered explicitly in the context of their influence on each other.

A forecasting and planning system that exhibits this iterative property between normative and exploratory processes has been used in the U. S. Air Force Flight Dynamics Laboratory for the past five years (1). It adresses resource allocation questions in the substantion phase, where the contributions of technology development efforts to long-range application concepts are reasonably clear. It accepts any number of forecasts in many technology areas and shows their implications for the achievement of objectives. It also accepts any number of objectives and shows their implications for technological development.

Before the introduction of the system, resource allocations were based heavily on " last year's budget " and the relative persuasiveness of program advocates—a not uncommon situation. Use of the system has resulted in these factors' exerting substantially less influence, and allocation discussions are focused on relative values of programs throughout the laboratory, rather than on dramatic appeals for pet projects. Laboratory management was also much better equipped to identify and examine marginal projects in more detail.

This system is also used as a management information system (2). Many information requests from both Laboratory and higher level management are answered within the planning office, thus relieving engineering talent from this task. The timing of information needs of the system are now being phased into the budgeting cycle which will further reduce reporting burdens on engineers and increase the influence of the system on the management of resources.

Another important benefit of this system is its identification of what data are needed for resource allocation. Every bit of information asked for is used and exerts explicit influence on allocation recommendations, and no additional information is felt to be needed – a truly unique situation.

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(1) Nutt, A.B., " An Approach to Research and Development Effectiveness ", *IEEE Transactions on Engineering Management*, Vol. EM-12, No.3, September, 1965.

(2) Nutt, A.B., " Ancillary Benefits of an Automated R & D Resources Allocation System ", *The American Society of Mechanical Engineers*, New York, N.Y. October, 1966.

The previous discussions focused on models currently being developed to aid decisions in the Substantiation Phase. But even though the pre-discovery phase of science presents a fundamentally different process to deal with, the idea of a useful forecasting and planning system need not be abandoned. Here, the obejctives are answers to basic questions of current research interest. Progress can be measured in terms of change in the structure of knowledge, and its value might be considered to be proportional to the magnitude of the change and the pervasiveness of its influence in the scientific community. Given this kind of value structure, the resource allocation and feedback functions can remain the same. We are now working with a Federal agency that supports basic research on this problem, using solid state physics as a case study. However, we are still in the Creation phase, and although our work seems promising, it is still too early to state conclusions.

This work is not only applicable to planning, but it also suggests the possibility for a fundamentally different science information system than currently exists. The process of structuring knowledge requires the identification of entities, mechanisms, properties, the relationships among them, and an indication of the level of certainty of the relationships. If scientific information could be generated, stored and retrieved routinely, a scientist could expect answers to substantive questions about the current state of knowledge, along with the appropriate references. He now can expect only quantities of references in response to key work queries and must then search through it to see if the answer to his question is there. And, of course, the smaller the number of references he has to look through, the greater the chance that it has been missed.

If such an information system could be developped, it would be of great value to both the scientist and the administrator in deciding what they should do next. With the help of a time-sharing computer, they could explore particular research alternatives that would improve the level of understanding of the relationships among entities, mechanisms, and properties or that would add or substract major variables and relationships. Since this structure would be highly interrelated, an estimate could be made of the pervasiveness of the influence of potential changes that could be made by alternative research projects.

Such a facility could be developed with relatively little additional effort than is spent now in the evaluation of proposals. If proposers would prepare both the substantive background information and descriptions of their projects in the proper form, data could be extracted readily and sent to a central source. The data bank would build up over time and would be as current as possible, since current proposals would be the primary information source. Even if the proposed work would be too sensitive for access by all interested scientists, the background references alone would serve to build up a useful facility. The development of such a capability would permit both industry and government to follow scientific advancement without a massive effort.

These approaches would be most useful for exploratory forecasting and planning in the pre-discovery phase, but they focus exclusively on scientific merit. The implications for goals and objectives of industrial and government organizations are not clear. This transition presents one of the most important challenges to forecasters and planners. Mission-oriented basic research agencies are concerned and frustrated by the apparent conflict in their work. They must justify both good science and mission relevance, but if relevance is obvious the work is probably not basic. Technology-based industries are also concerned about missing scientific opportunities, but even when questions that are important to science can be identified, the relevance of their answers to corporate objectives is not obvious. About all that can be done now is to estimate separately the scientific merit of proposals and their relevance to goals and objectives. The relative emphasis that should be placed on these estimates is a task that is left to policy-level management.

Several U. S. Government agencies that support basic research have initiated small study efforts to trace the subsequent use of scientific findings in productive applications, but they are only a beginning. The development of methods to predict transfer mechanisms is a fruitful research area for the energies of technological forecasters and planners. Improved understanding could reduce both the time required to go through the RDT & E Phases and the time required for interdisciplinary and interindustry transfers within a given phase.

PROPOSALS

There are further opportunities for forecasters and planners, both in designing new models and systems and in getting existing techniques used more widely.

One opportunity for further modeling and system design is the integration of systems to " improve the coupling between successive RDT & E Phases " (1). Such integration efforts would not only serve to guide work in successive phases, but they would also provide guidance for the proper balance of resource allocations among the phases. Top management has long been made uncomfortable by the nagging question in the back of the mind that inquires, " Could we have been in a better competitive position if we had spent a little more on R & D ? Our product could have had better performance with fewer production problems. The reduced production costs alone could have paid for it. But on the other hand we might have entered the market too late. It might have been better to spend less on R & D, started production earlier with a lower performance product and made more improvements as others were attracted to the market ". An important role of the forecaster and planner is to give advice on these questions, and integration of models to examine these crucial allocation and timing decisions is a good way to start.

There is an opportunity for us to integrate some of our own model designs. The integration of scenario generation (2), multiple contingency planning (3), systems planning (4), evaluation (5), and exploratory development planning (6) could cover Normative Planning for both Technology and the Environment in the Creation, Substantiation, and Development Phases to give advice on allocation trade-offs between military systems and exploratory development. It would be an ambitious undertaking, but it does appear feasible. Perhaps an industrial problem of smaller scope would be a better starting point.

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(1) Jantsch, Erich, op. cit., p.20.

(2) Bornstein, Stephen A., " A Scenario Generation Methodology ", *Development of Planning Methods for the Support of the Fundamental Space Operations Study,* Vol.III, SPAD Management Office, Air Force Systems Command, May 1966.

(3) Rea, Robert H., Peter S. Miller, " The Multiple Contingency Concept of Long-Range Technological Planning ", *Technological Forecasting for Industry and Government,* James R. Bright (ed.), Prentice-Hall, Inc., N.J., 1968.

(4) Rea, Robert H., *A System Development Planning Structure,* Air Force Systems Command, May, 1966.

(5) Miller, Peter S., Clark C. Abt, " A Procedure for Force Structure Effectiveness Evaluation " *Development of Planning Methods for the Support of the Fundamental Space Operations Study,* Vol. III, SPAD Management Office, Air Force Systems Command, May, 1966.

(6) Nutt, A.B., op. cit. IEEE article.

All of the models mentioned above use existing data at several levels of detail and process it to give advice on optimal resource allocation ; they do not suggest new opportunities that could be generated by combining the data in different ways. One such " suggestive " model for industry could be based on the concept of the rate of constraint relaxation.

Almost any industrial organization could be in almost any business – eventually. In the short run, organisations are limited in their actions to making relatively small changes from their current investments in plant, equipment, and skilled manpower. However, each of these constraints could be relaxed at different rates, and possibly should be " traded in " for new kinds of constraints if greater opportunities could be perceived in another business. Inputs to such a model would come from technological and market forecasters of all kinds – some from outside the company. Additional inputs would come from within the company – those that estimate the rates at which current constraints could reasonably be relaxed. The output of the model would focus on timing. It would match the kinds of resources that could be made available internally with the kinds of resources required to take advantage of future opportunities and generate those opportunities as a function of time. Of course, their number would increase with time, and the task of planners and management would be to reduce their number and to " try out " the adoption of new opportunities in the simulated organization that could exist at the time with the aid of feedback loops.

One advantage of a suggestive model is that " unreasonable " opportunities must be rejected explicitly – and for some reason. If it could be agreed that such a reason was a good one, the model could be programmed not to generate other opportunities that would be rejected for the same reason. Using this process, model outputs would converge toward producing only " reasonable " opportunities.

The forecasting and planning community should continue to maintain acute awareness of developments in social accounting and social indicators and contribute to them actively. Technological forecasters and planners should be intimately familiar with the basic processes involved in goal determination, program selection, identification of indicators of change, data collection, and real time feedback that will be used in such systems. The form that social accounting systems will take and how the primary issues will be resolved is not yet clear, but their development will add an important new dimension to the technological and economic modeling inventory.

A major problem that faces forecasters and planners of all kinds is getting the results of their efforts used. Planners can develop increasingly sophisticated tools, make plans that are clever and ingenious, be appreciated by other planners, but never see anything happen in the area being planned for that resulted from their brilliance. One of the first steps in the drive for utility should be the development of plans using variables and processes that are of direct relevance to operational decision-makers to make it possible at least to follow the plan – just in case anyone wanted to. The next step is to design a planning system to make it clear to operations people just what the consequences are of not following the plan. As our ability to link together tactical and strategic planning throughout an increasingly larger number of RDT & E Phases improves, we shall be able to project these consequences further into the future.

Although it may seem obvious that rational management would be quick to recognize the great value of a new strategic perspective that could be made available to them by embracing the ideas and trappings of technological forecasting and planning, they have not yet done so in large numbers. Perhaps this inaction on their part arises from the fact that ours is a newly emerging field of study, and they simply haven't yet seen convincing results. However, it is more likely that books about forecasting and the technology gap and conferences and reports of conferences about the wonders and problems of forecasting and planning do not incite management to action because of a perceived lack of relevance to its own unique problems. If we are to be of benefit to industry and government, we must take the time to seek out individuals within these institutions who are both concerned and influential and demonstrate to them that their use of appropriate forecasting and planning tools would result in greater benefits than costs.

QUESTIONS FOR FURTHER RESEARCH

Methodological improvements need to be made in each of the functional areas needed to assemble a long-range forecasting and planning system. Some of the more important ones are described briefly below, listed by function.

Objectives

The process of definition and valuation of objective needs much improvement. Matrices and relevance trees require many subjective inputs from single decision makers that rarely exist. The work of Olaf Helmer (1) and Howard Wells (2) in obtaining group consensus and Marvin Manheim's (3) work

(1) Helmer, Olaf, " Analysis of the Future : The Delphi Method ", *Technological Forecasting for Industry and Government,* James R. Bright (ed.),Prentice-Hall, Inc., New Jersey, 1968.

(2) Wells, Howard A., Unpublished Ph. D. Dissertation, Ohio State University.

(3) Manheim, Marvil L., *Hierarchial Structure : A Model of Design and Planning Processes,* Cambridge, Mass. : M.I.T. Press, 1966 .

in hierarchical structuring show promising avenues for improvement. The use of mathematical modeling to reduce the number of subjectively derived variable values also shows promise, but more work is needed in developing greater understanding of the processes involved to improve the validity of the logical relationships required.

Methods must be found to integrate data that will become available as social accounting and social planning, programming, and budgeting systems are put into operation. Research into cause and effect linkages between technological and social change would contribute to ease of integration.

Integration of long-range marketing studies with technological forecasts would contribute to the utility of both. This requires research into ways of matching variables at the interface and estimating quantitative demand changes that would result from technological advancement.

Contribution of Opportunities to Objectives

Improved methods of historical tracing of the economic and social utility of research results are needed to identify transfer mechanisms and to predict which ones appear most propitious as mechanisms for realizing the potential benefits of current research results.

The transition from discipline to function orientation is a difficult one. The degree of contribution of discipline-oriented project proposals to function-oreinted programs and objectives need to be measured, but the people available for this task are usually advocates of one or the other orientation, and the process of measurement often turns into one of influence. Perhaps mathematical models of the functional process could experiment with different levels of disciplinary performance to measure the contribution.

The advancement made over time of indicators of technological progress depends on resources allocated by a group of people whose members are often unknown to each other and are allocating in different environments. However, the best allocations for any single member depends on what the others do. Since they have little direct influence on each other, one way of accounting for their interactions is to consider most of the multiple contingencies that are plausible within the framework of the forecasting and planning system. Better ways of handling these many possibilities, than brute force enumeration, are needed.

Forecasts

Improvements in forecasting methodology should be sought through efforts to understand the *process* of technological advancement in greater detail by seeking cause and effect relationships in the mechanisms of scientific advancement and technology transfer. This approach should be much more fruitful than continuing the more speculative correlation approaches of extrapolation and envelope curves.

Allocation

Whether or not more objective probabilities are forthcoming, mathematical optimization techniques need to be developed that will handle probability distributions directly, rather than depending on deterministic expected value calculations.

Although there are no fundamental limitations to design, experience needs to be gained in the operation of forecasting and planning systems that incorporate decision rules for adaptively modifying programs and objectives as a result of resource limitations in supporting R & D projects.

Validation

Although it may seem obvious to some that more careful and comprehensive use of information as a prerequisite for decision making is " good ", others must be shown that things will be somehow " better than we're doing it now " if resources are spent in forecasting and planning. Research is needed to be quite explicit about how much can be said about the benefits of the activity. Perhaps it cannot be demonstrated in the general case, and preliminary designs of " typical " forecasting and planning systems for specific industries and government agencies will have to be made to address the question of relevance.

It would be highly desirable to conduct an experiment with two organizations in the same competitive environment, providing one with competent forecasters and planners and denying it to the other, with differences in performance being attributable to planning or the absence of it. Although this experiment may not be feasible in the real world, perhaps simulated situations could produce results that were instructive, if not convincing.

SUMMARY

Methodology in technological forecasting and planning should be developed in two areas. The first is in improved forecasting by making efforts to understand the *process* of technological advancement in greater detail – to seek cause and effect relationships and mechanisms of scientific advancement and technology transfer. The second is in taking forecasts – not in the form of a single speculation about what *will* happen, but in the form of different things that *could* happen if specified levels of resources were applied – and incorporating them into resource allocation systems. These systems will provide meaningful advice to managers faced with current decisions about the support of alternative efforts in technological innovation that will determine their organization's position in the market of the not-too-distant future.

Although work in the first area (of improved forecasts through improved understanding of the process) is important, the development of new and useful methods will be slow. However, this problem is of little consequence to technology-based industries with long lead times between discovery and application. It is now possible for any corporation or government agency to be advised on the best choice of technological development it should make in order to achieve and maintain substantial influence in the competitive environments of the future – given enough effort. This reduces the problem to deciding how much effort is appropriate.

Increasing effort results in increasing benefits and increasing costs. Both the benefits and costs of alternative forecasting, planning, and resource allocation systems can be estimated by identifying the functions that must be performed by the system and enumerating and analyzing alternative analytical tools that can be used to perform the functions.

The required functions are :

1. Identification and Valuation of Objectives
2. Contribution of Alternative Technological Opportunities to the Objectives
3. Sensitivity of Progress to Rate of Resource Application (forecasts)
4. Strategy
5. Resource Allocation

The paper enumerates and alanyzes briefly, several analytical tools of varying levels of complexity that can be used to perform each of the five functions. The advantages, limitations and costs of the use of each tool are discussed, and problems of trade-offs for choice are presented.

Both problems that have been encountered and opportunities uncovered during the process of designing and implemeting several forecasting, planning, and resource allocation systems are presented.

The problems are :

1. Reducing dependence on subjectively-derived values of objectives ;
2. Integrating long-range marketing studies with technological forecasts ;
3. Tracing the process of deriving economic and social utility from research results to predict future transfer mechanisms ;
4. Making transitions from discipline to function orientation ;
5. Handling large numbers of contingencies ;
6. Incorporating probability distributions into mathematical optimization techniques ;
7. Demonstrating the utility of forecasting and planning ;
8. Improving the accuracy of forecasts by studying cause and effect relationships in the process of discovery, development, and transfer.

The opportunities are :

1. Integrating forecasting and planning systems throughout the RDT & E phases ;
2. Designing a suggestive forecasting and planning model for industry, based on the concept of plausible rates of constraint relaxation ;
3. Incorporating data that will become available as social accounting and social planning, programming and budgeting systems are developed.

As these problems are reduced, opportunities realized, and systems implemented, the technological forecasts and long-range plans that result will contribute to significant improvements in our ability to cope with the uncertainties of the future.

PLANNING UNDER THE DYNAMIC INFLUENCES OF COMPLEX SOCIAL SYSTEMS

by

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Long-range forecasting and planning are not acts done to an unresponsive object. They are activities carried on within, and as part of, an interacting system. To think of planning as unilateral or as a leader setting the way for the system to follow, is dynamically incorrect. Planning is based on information coming from the remainder of the system. If planning has any influence, it alters the system which then produces new information on which further planning is based.

Forecasting -- a Part of the Surrounding System

To understand planning, and to understand its failures, we must see the planning process as part of the total structure of a social system. Long-range forecasting and planning methods are in no sense different from any other policy that controls action within a system. Methods and policies are based on current information which convert that information into a present course of action. There is no information available to us out of the future. There are no actions which we can take in the past or the future. We act only in the present. Long-range planning is simply another of our many processes for converting history into current activity.

If forecasting and planning do not differ in principle nor in time of occurrence from other system decisions, then what distinction has planning? Often long-range planning has no distinction from other system decisions. It identifies a problem and then establishes an action to alleviate the problem.

But planning can have a different structural, if not temporal, relationship from ordinary decision making when we examine how planning might be related to a social system. Planning, instead of dealing with problems and their solutions, could deal with the design of social systems to produce systems less likely to generate problems. Planning, if addressed to the design of social systems, would ask not how to fix the present difficulties, but instead what leads the system into undesirable conditions. With the structure and cause of problems identified, one can then move to avoid such problems rather than to encounter them repeatedly and attempt to alleviate them.

Planning too often seems to be a process of arbitrarily setting a goal. The goal-setting is then followed by the design of actions which intuition suggests will reach the goal. Several traps lie within this procedure. First, there is no way of determining that the goal is possible. Second, there is no way of knowing that the goal has not been set too low and that the system might be able to perform far better. Third, there is no way to be sure that the planned actions will move the system toward the goal. The history of social planning demonstrates that these hazards are real. The alternative is to examine the design of the social system, to understand the reason for its behavior, and to change its structure and policies to produce a system that operates as effectively as we can devise. With such an approach to system design we should be able to reach goals that would have seemed unrealistic and which we would not have dared set in the conventional planning process.

The Nature of Complex Systems

To understand the dangers and frustrations of planning and on the other hand the possibilities, one must know something about the nature of complex systems. " Complex systems " as used here refers to high-order, multiple-loop, nonlinear, feedback structures. All social systems belong to this class. The management structure of a corporation has all the characteristics of a complex system. Likewise, an urban area, a national government, the processes of economic development, and international trade all are complex systems. Complex systems have many unexpected and little understood characteristics.

Before discussing these characteristics, the structure of a complex system should be explained. Like all systems, the complex system is an interlocking structure of feedback loops. " Feedback loop " is the technical terminology describing the environment around any decision point in a system. The decision leads to a course of action which changes the state of the surrounding system and gives rise to new information on which future decisions are based. This loop structure surrounds all decisions public or private, conscious or unconscious. The processes of man and nature, of psychology and physics, of medicine and engineering, all fall within this structure. But the complex system has some special characteristics.

The complex system is of high order. The order of a system is equal to the number of integrations or accumulations within the system. The order of the system is equal to the number of states necessary to describe the condition of the system. In a company, we might have separate states representing the employees, the bank balance, the finished inventory, the in-process inventory, the physical machinery, various psychological attitudes, components of reputation, and elements of tradition. A system of greater than fourth or fifth order begins to enter the range here defined as a complex system. An adequate representation of a social system, even for a very limited purpose, can be tenth to hundredth order.

A complex system is multiple loop. It will have upward of three or four interacting feedback loops. The interplay between these loops and the shifting dominance from one to the other gives the complex system much of its character.

The complex system has both positive and negative feedback loops. The negative feedback loop is most common in the literature and is almost the only one discussed in engineering. But it is the positive feedback loop which generates all growth processes whether they be biological or economic. Negative feedback loops are goal-seeking, tending to regulate the system toward some objective. Positive feedback loops are goal divergent, tending to depart exponentially from some point of unstable equilibrium. But the positive feedback character which gives the positive loop its growth behavior comes not from structure alone, but depends also on numerous variable factors around the loop. These factors are often set and controlled by other loops in the system. As these factors change, the positive growth loop can be depressed in its regenerative characteristics and brought to a neutral point marking the boundary between positive and negative feedback behavior. If the loop is pushed into the negative feedback region, the loop begins to generate exponential collapse toward the original reference point from which it had been diverging. The behavior of social systems is intimately related to this interaction between positive and negative feedback processes.

The complex system is nonlinear. Modern mathematics deals almost exclusively with linear processes. Life and society deal almost entirely with nonlinear processes. It is the nonlinear coupling which allows one feedback loop to dominate the system at one time and then to cause this dominance to shift to another part of the system which may produce such different behavior that the two seem unrelated. It is the multiple-loop realignment along various nonlinear functions which makes the complex system so highly insensitive to most system parameters. It is the same nonlinear behavior which makes the system so recalcitrant in resisting efforts to change its behavior. It is the nonlinearities, when understood, which make it relatively easy to produce system models with realistic dynamic characteristics. It is in the range of nonlinear relationships that so much of our knowledge about system components resides. Only by dealing forthrightly with the nonlinearities in systems, shall we begin to understand the dynamics of social behavior. Nonlinearity is easy to handle once we stop demanding analytical solutions to systems of equations and accept the less elegant and more empirical approach of system simulation. The acceptance of the nonlinear nature of systems shifts our attention away from the futile effort to measure accurately the parameters of social systems and instead focuses attention on the far more important matter of system structure.

These complex systems have characteristics which are commonly unknown. They are far different from the simple systems on which our intuitive responses have been sharpened. They are different from the behavior studied in science and mathematics where only simple systems have received orderly attention and analysis.

Complex social systems bring together many factors which, by quirks of history, have been compartmentalized into isolated intellectual fields. The barriers between disciplines must melt away if we are successfully to cope with complex systems. Within the same system we must admit the interactions of the psychological, the economic, the technical, the cultural, and the political. The interactions between these are often more important than the internal content of any one alone. Yet, if they are isolated in our study and in our thinking, the interactions will never come into view.

Complex systems have some important behavior characteristics which we must understand if we expect that planning will lead to systems of better behavior. Complex systems are counter-intuitive. They are remarkably insensitive to changes in many system parameters. They counteract redirections in policy. They often contain a delicate balance with positive loops poised between growth and decline, presenting thereby both hazards and opportunities. They tend toward minimum performance and the least desirable behavior. Each of these characteristics will now be examined in more detail.

As a first characteristic of complex systems, their behavior appears counter-intuitive to the average person. Intuition and judgment, generated by a lifetime of experience with the simple systems that surround one's every action, create a network of expectations and perceptions which could hardly be better designed to mislead the unwary when he moves into the realm of complex systems. One's life and mental processes have been conditioned almost exclusively by what are technically known as first-order, negative-feedback loops. Such a loop is goal-seeking and contains a single important system state variable. For example, one can pick up an object from the table because one senses the difference in position between hand and object and controls movement to close the gap. While there are many nervous and muscular responses involved, the system is dominated by the state variable representing the position of the hand. One is able to drive an automobile because one senses the position of the car on the road and adjusts the steering wheel to maintain direction. From all these experiences one learns the obvious and ever-present fact that cause and effect are closely related in time and in space. A difficulty or failure of the simple system is observed immediately. The cause is obvious and immediately precedes the consequences. But when one goes to complex systems all of these facts become fallacies. Cause and effect are no longer closely related either in time or in space. Causes of a symptom may actually lie in some far distant sector of a social system. Furthermore, symptoms may appear long after the primary causes. But the complex system is far more devious and diabolical than merely being different from the simple systems with which we have had experience. Not only is it truly different, but it appears to be the same. Having been conditioned to look close-by for the cause of the trouble, the complex system provides a plausible relationship and pattern for us to discover. When we look nearby in time and in location, we find what appears to be a cause, but actually it is only a coincident symptom. Variables in complex systems are highly correlated, but time correlation means little in distinguishing cause and effect. Much statistical and correlation analysis is futilely pursuing this will-o'-the-wisp. It always seems that better information would explain system behavior but as data becomes better the explanation continues to elude. Having been led into a situation where one finds coincident symptoms and believes them to be causes, he then acts to dispel the symptoms. But the underlying causes remain. The treatment is either ineffective or actually detrimental. With a high degree of confidence we can say that the intuitive solutions to the problems of complex social systems will be wrong most of the time.

A second characteristic of complex systems is a remarkable insensitivity to changes in many of the system parameters. Social science attempts to measure to a high precision many of the characteristics of psychological and economic systems. Yet models of those same systems show little change in behavior even from parameter changes of severalfold. Contemplating our social systems indicates that this must be true. The life cycle of companies follows similar patterns in very different industries and even in different countries. Problems in economic development are much the same regardless of continent, or race, or even of the availability of raw materials. Economic systems have behaved in about the same way over the past hundred years even though the developed countries have shifted from agricultural to urban societies, from independent to central banking, from individual entrepreneurships to large corporations, and from communication delays of weeks to seconds.

A third characteristic of complex systems is their recalcitrant resistance to policy changes. A policy is composed of both a structure (that is, what information sources are selected and how they are used) and parameters (determining how much influence from the information and how much action). The insensitivity of a system to most of its parameters means that the system is insensitive to most efforts that would be called policy changes. Here lies the explanation for the stubborn nature of social systems. When a policy is changed, the many system levels shift slightly and offer a new ensemble of information to the policy point in the system. The new information, processed through the new policy, gives nearly the old results.

But a fourth characteristic of complex systems is a high sensitivity to a few parameters and a sensitivity to some changes in structure. Therefore, to help confuse the observer, the converse of parameter insensitivity is also true. There are a few points in any system to which behavior is sensitive. If these points are changed, they cause pressures to radiate throughout the system. Behavior everywhere seems to be different. But it is not because people have been persuaded or forced to act differently. It is because, responding in the old way to new information, they naturally take different actions. The parameters and structural changes to which a system is sensitive are usually not self evident, they must be discovered through careful examination of system dynamics.

A fifth characteristic of complex systems is a frequent condition of delicate balance between the forces of growth and decline. The system responsiveness to some sensitive pressure points seems to come because of this precarious balance. In equilibrium, complex systems have ceased to grow. But the positive growth loops are still structurally present. They have simply been depressed into inactivity by variables that are controlled from other loops and which act as gain factors in the growth loops. This whole structure is poised between growth and decline. The balancing factors can shift inadvertently toward deterioration or be modified by design to shift the system toward healthy, effective operation.

In coping with this uncertain balance, one often cannot and may not want to shift in the direction of resumed growth. This may be quite impossible or highly undesirable. But one may want to move the system out of the region of delicate balance and be sure that it presses hard against some carefully chosen operating limit as a protection against a high sensitivity to external conditions which may lead unexpectedly into crisis.

As a sixth characteristic of complex systems, we can expect that they will drift to a low level of performance. There are several reasons for this. One is that complex systems often show quite opposite directions of response in the short run from those in the long run. A particular change in policy may improve matters for a period of a year or two while setting the stage for changes that lower performance and desirability a few years or decades hence. But the natural interpretation is to observe that good resulted from the change. When matters become worse the original efforts are redoubled, producing again a short-term improvement and still deeper long-term difficulty. Again the complex system is cunning in its ability to mislead.

Social System Design

To bridge between goals and implementation, one must have an understanding of the dynamic character of complex systems. Otherwise judgment based on simple systems can lead to the ineffective expenditure of large amounts of money and to programs which actually make the situation worse.

Because the models of complex systems are far beyond the reach of mathematical methods, analytical solutions to sets of equations describing such systems are impossible. The only avenue is computer simulation using models of the systems. In computer simulation the computer follows the rules of behavior of the system to generate moment-by-moment the changing state of the system. The rules which the computer follows are called a model.

A simulation model is a theory describing the structure and interrelationships of the system. The fact that the simulation process is to be used does not of itself make the theory correct. Models can be useful or useless. They can be soundly conceived, inadequate, or wrong. They can be concise and clear and describe only those characteristics of the real system necessary to give it the behavior characteristics of interest, or they can be verbose, obscure, and cluttered with unimportant detail so that they confuse rather than inform. They can be structured with recognition of the dynamic principles of feedback systems structure, or they can simply be a catchall for observed fragments of the system while omitting the essential structure. Correct concepts of structure must guide model building (1).

The planning of corrective action for social systems usually takes the form of identifying a problem and proceeding to devise programs for change. Often these programs are addressed only to symptoms , but symptoms are hard to change if causes remain. We cannot treat causes unless we understand them. The first step then in modeling is to generate a model which creates the problem (2). Only if we understand the processes leading to the difficulties can we hope to restructure the system so that the internal processes lead in a different direction. If the model is to create the difficulties, it means that the model contains all the interacting relationships necessary to lead the system into trouble. It follows that the troubles are not imposed on the system from outside of the structure being modeled. It further follows that the model will be a closed model which is not dependent for its inherent characteristic behavior on any variables transmitted across its boundary from the external world.

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(1) Forrester, Jay W., *Industrial Dynamics,* Cambridge: The M.I.T. Press, 1961.
Forrester, Jay W., *Principles of Systems,* preliminary edition, privately published, 1968, available from Technology Store, M.I.T. Student Center, 84 Massachusetts Avenue, Cambridge, Massachusetts.

(2) Forrester, Jay W., " Market Growth as Influenced by Capital Investment ", *Industrial Management Review,* Vol. IX, Number 2, Winter 1968, pp.83-105.

The concept of the closed boundary and the development of a simulation model which has within itself all of the generating mechanisms for the problems of the system is essential to successful investigation of complex systems (1).

Within the boundary of the system the basic building blocks will be the feedback loops surrounding the decision points. These building blocks include both the positive and the negative feedback loops. They interact and interconnect. They give graphic and structural reality to the concept that cause and effect are not unidirectional but are closed paths. Cause produces effect which changes the state of the system and reacts on cause.

Whithin the feedback loop the principles of system structure tell us that there are two and only two kinds of variables. One kind is generated by the process of integration and is called the level variable in industrial dynamics, the state variable in the field of engineering, and the balance sheet variable in accounting. The other variable is the action variable, called the rate variable in industrial dynamics, flows in economics, and profit and loss variables in accounting. Furthermore, these two variables are arranged in an orderly way. They alternate along any path through the flow diagram of a system. Rate variables depend only on level variables. Level variables are caused to change only by the rate variables. Levels can never directly affect other levels without acting through intervening rates of flow. It is conceptually impossible for rates directly to affect one another. These concepts of structure are powerful and effective guides in the building of models to represent social systems. Failure to follow them will lead to confusion.

Working with a simulation model of complex system interactions begins to show why the system behaves the way it does. It shows why direct action characterized by a frontal assault on the trouble points in the system can often be futile. It can show us that great improvement can often be generated at small cost if the critical pressure points within the system can be identified.

From the viewpoint of system planning, a system study takes the emphasis off the correction of difficulties. Instead, it focuses attention on the causes of difficulty and their removal. Removing causes may take quite different actions from those aimed at alleviating symptoms. The cost of removing causes is often far less. The influence is much deeper. The improvements last longer.

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(1) Forrester, Jay W., " Industrial Dynamics—After the First Decade " *Management Science,* Volume 14, Number 7, March 1968, pp. 398-415.

Good planning based on a deep insight into the behavior of complex systems will attempt to release the internal power, initiative, driving force, enthusiasm, and human potential of the people in the system. It will do this instead of heaping more work, more discipline, more repression, and more coordination on them in an effort to push back a social system that is still trying to go in the wrong direction.

An Example – the City

The preceding discussion of systems can be illustrated by extracts from a book I have just completed (July 1968) on the dynamics of an urban area (1). The objective of the study has been to understand the reasons for deterioration in aging urban areas. The city grows in a healthy aggressive manner, goes through a period of maturity, and then enters a phase of stagnation in which jobs decline, the population shifts toward an underemployed class with limited economic skills, and city expenses rise while revenues decline. The system study was aimed first at understanding this process. Second, it was used to explain why most of the efforts in the past three decades to cope with the urban problem have failed. Third, it has pointed the way toward some quite different policies which might generate revival in stagnated city areas.

The study of urban dynamics was made using a simulation model which is a theory of urban structure and interactions. This theory must first identify the closed system which generates the social problems observed in a declining city. Figure 1 shows the central framework identified by the theory. Nine principal system levels are represented by the rectangles. The 22 major flow rates are shown by the valve symbols. Because of the great complexity of interconnection, the figure does not show the information linkages from the levels to the rates. Figure 1 represents the system lying inside the closed boundary, and represents the processes which this theory asserts to be sufficient to account for the growth, maturity, and stagnation of a city. The cloud symbols represent flows that go to or from a non-interacting environment. People move to and from an external world which is taken as neutral and nonreactive. This assumption is valid so long as the external world is not itself

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(1) Forrester, Jay W., *Urban Dynamics,* The M.I.T. Press, Cambridge, Massachusetts; probable publication date April 1969.

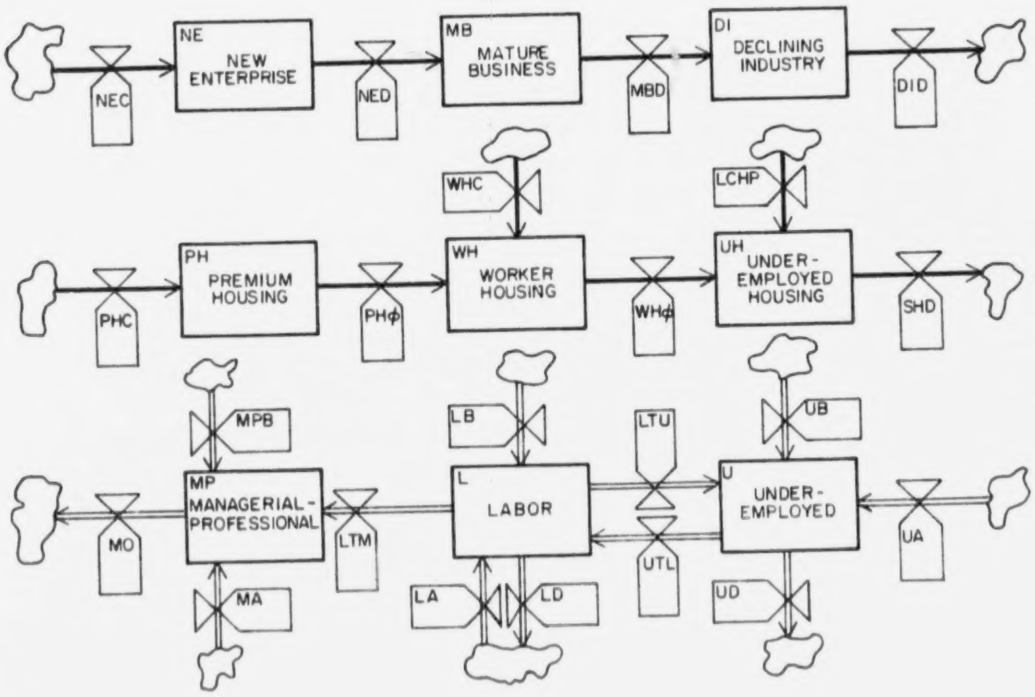
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Figure 1 Central structure and major levels in theory of urban dynamics.

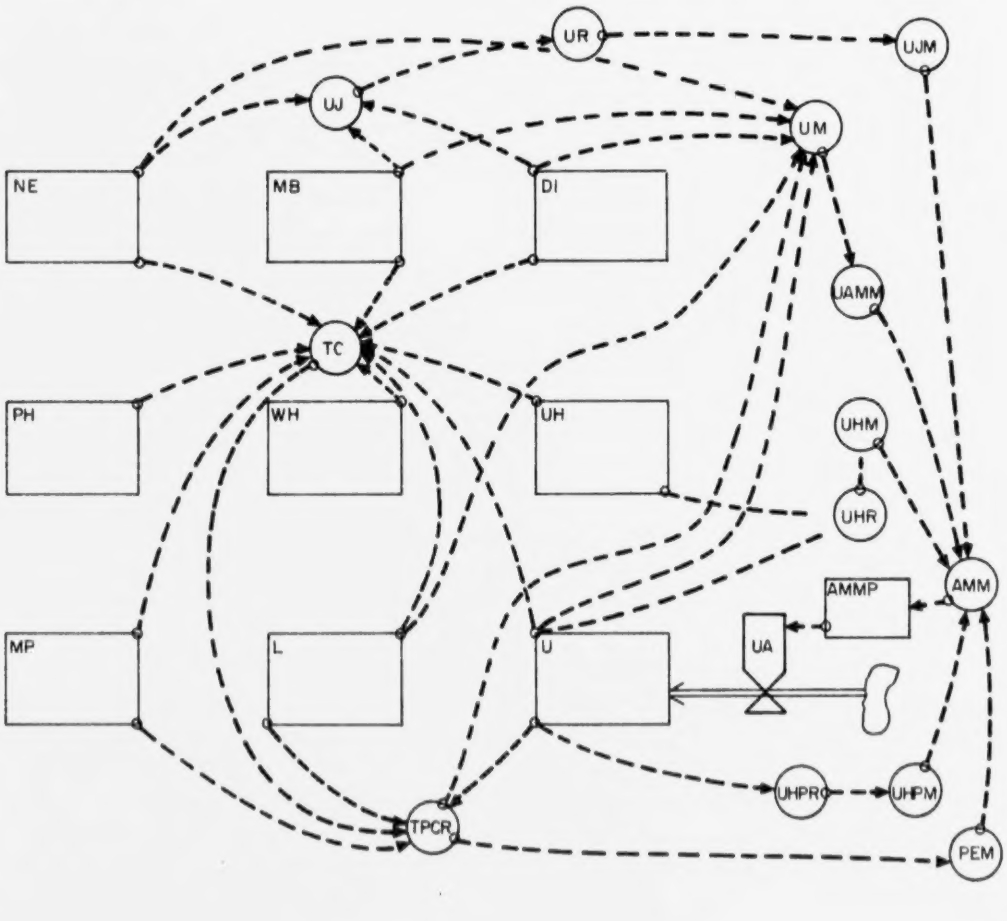
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Figure 2

The network of influences connecting system levels to the underemployed arrival rate.

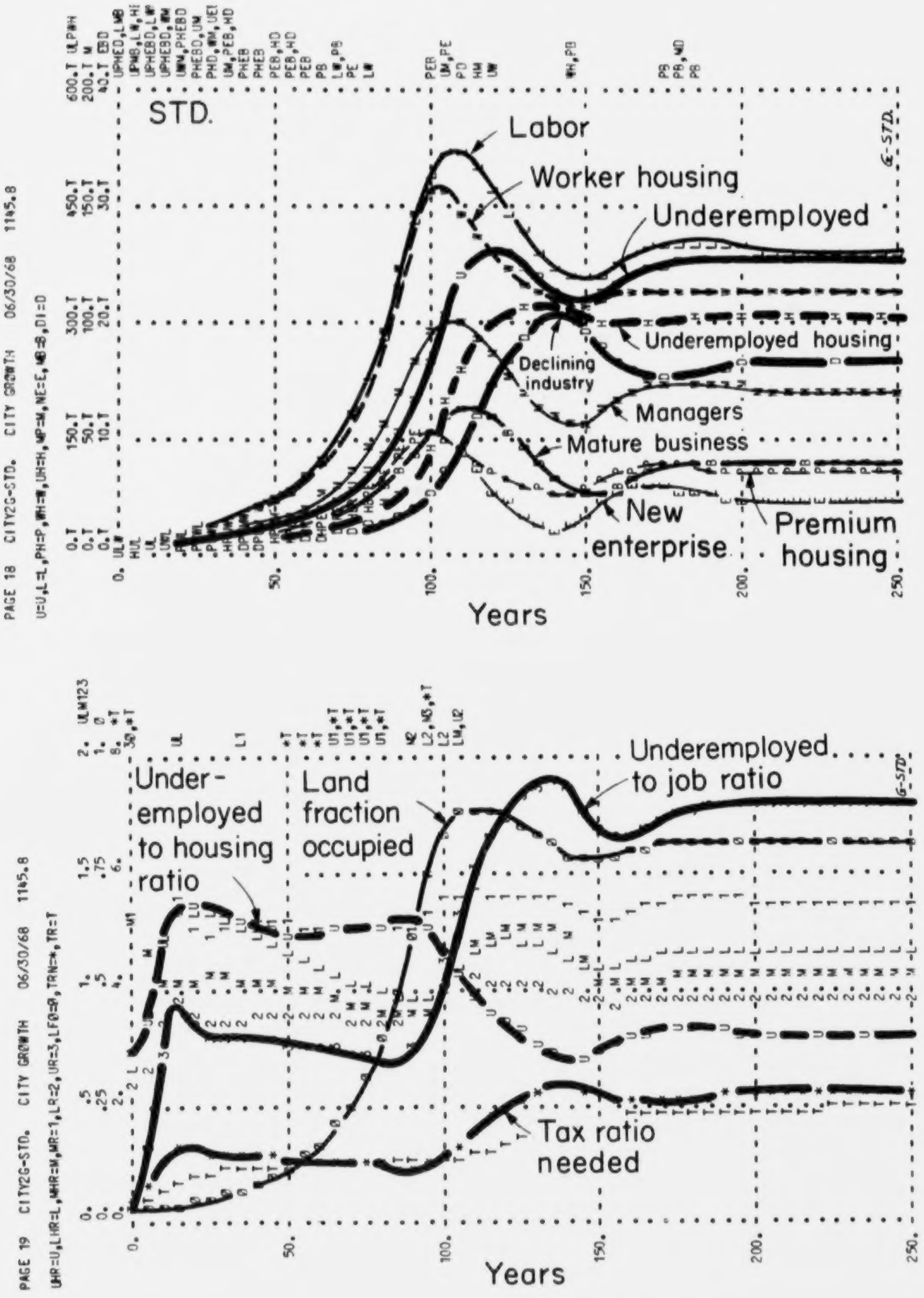
directly and intimately responsive to what happens in the city. The outside is a limitless environment from which people come to the city and to which people go from the city. The flows are not imposed on the city by the environment but instead are controlled by the city itself through the degree of attractiveness which it generates relative to the environment. The city is seen not as a victim of circumstances as so often described by city administrators. Instead, it is seen as a living organism which attracts people, which builds housing, and which generates new enterprise. It is also seen as a fixed land area in which the natural processes of aging and shifting balances explain the urban behavior.

Figure 2 shows diagramatically how one rate of flow in the system, the underemployed arrival rate into the city.,'s linked to the level variables of the system. Although not true for all of the system rates, this particular rate depends on each of the nine major levels. In a similar manner all other rates of flow are responsive to the system condition described by the level variables.

Space does not permit here more detail. The theory of urban structure is expressed in a model of some 150 equations that point-by-point throughout the system generate the important concepts and identify their interrelationships.

Figures 3a and 3b show how the theory expressed by the simulation model generates the process of growth and stagnation. The initial conditions are compatible with 3 % of the land occupied. The three classes of population, housing, and industry grow for the first 100 years. Then, as the land area becomes filled (the city is here described as a geographical area rather than a political entity), a series of changes occur over the next 50 or 100 years leading into an equilibrium condition. Equilibrium has a low level of new enterprise and a high level of declining industry. It has a number of underemployed almost equal to the labor group. Underemployed housing, much of which would be called slum housing, is 40 % of the total housing. The population has shifted from a good economic balance to a high proportion of those who need more and produce less. Figure 3b shows the sudden shift which occurs between years 75 and 150 during the period of maturity in the ratio of underemployed-to-jobs and the ratio of underemployed-to-housing. The underemployed become excessive in comparison to jobs, but they do not fill the available housing. This appears true in a society where the outside environment is not in desperate economic circumstances. Migration into the city is repelled by lack of available jobs but attracted by the available housing.

One of the basic concepts in this theory of urban dynamics is the " attractiveness " of the city. Attractiveness is made of many components. Two are shown here in Figure 3b as the underemployed-to-job ratio and the



Figures 3a and 3b

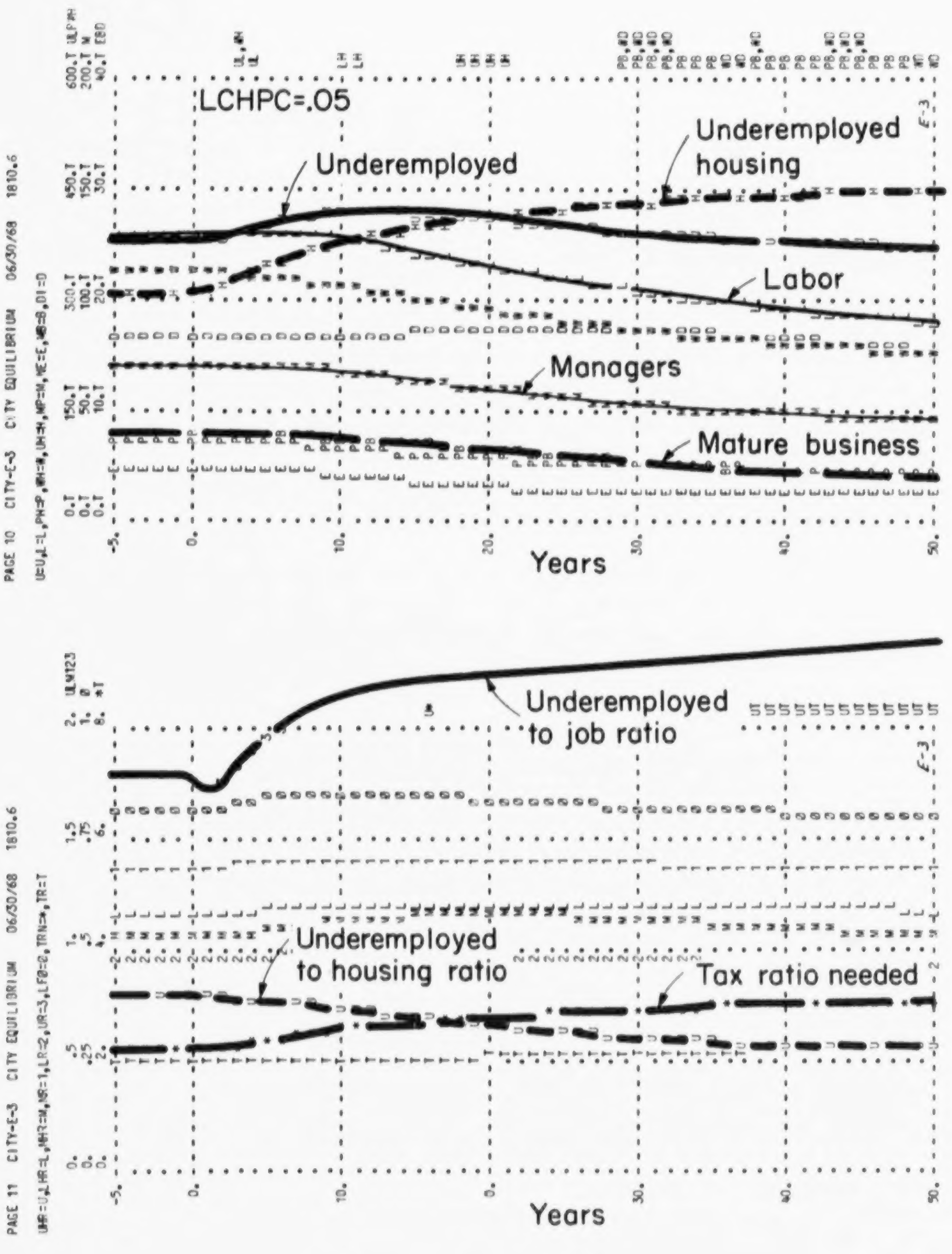
Growth, maturity, and stagnation of a city over 250 years as it fills its land area and ages.

underemployed-to-housing ratio. The attractiveness of the city to a particular class of person can, in equilibrium, only be that of the outside environment. If the city is more attractive, migration is inward until attractiveness is reduced. If the city is less attractive, migration is outward. For the lower economic level, inward migration will continue until the city attractiveness falls far enough to suppress migration. Here one must face reality in considering goals. The city does not have the option of increasing its total composite attractiveness over the outside environment. It can only change the mix of different components of attractiveness. Even so, there may be great merit for the well-being of the city and its inhabitants to alter the normal relationships between the components of attractiveness even if the composite attractiveness remains constant. For example, one might find a healthier city if the relative positions of the underemployed-to-job ratio and the underemployed-to-housing ratio were reversed. In such circumstances the lack of housing would limit migration into the city but those that were housed would have jobs and be effective parts of the city economy. This is quite the reverse of the theory occasionally propounded that population in a city should be controlled by limiting the work opportunities.

But many policies intuitively appealing, politically attractive in the short run, and apparently humanitarian, may lead in the wrong direction. Figures 4a and 4b show the effect on the stagnated equilibrium city if a program of low cost housing construction is inaugurated. Here the initial conditions are those finally reached in Figure 3. At time 0 a program is started and maintained which builds each year low cost housing for 2.5 % of the underemployed population.

Figure 4a shows an increase in underemployed housing. During the first ten years there is an increase in the total number of underemployed because of the attractiveness of the new housing. Thereafter the underemployed population declines because of the overwhelming disadvantages of the declining job and economic situation. The other curves show substantial declines in labor, managers, and business. Figure 4b shows precipitous increase in the ratio of underemployed-to-jobs meaning a rising level of unemployment. The underemployed-to-housing ratio which was already too low has fallen further. The quality of housing, which is not here a system variable, has probably increased which, if incorporated, might raise still further the number of underemployed and the degree of unemployment. Figure 4b shows a steady increase in the tax assessments needed.

Figures 4a and 4b show the recalcitrant and counter-intuitive nature of this system. An effort to improve the condition of the underemployed has quite



Figures 4a and 4b

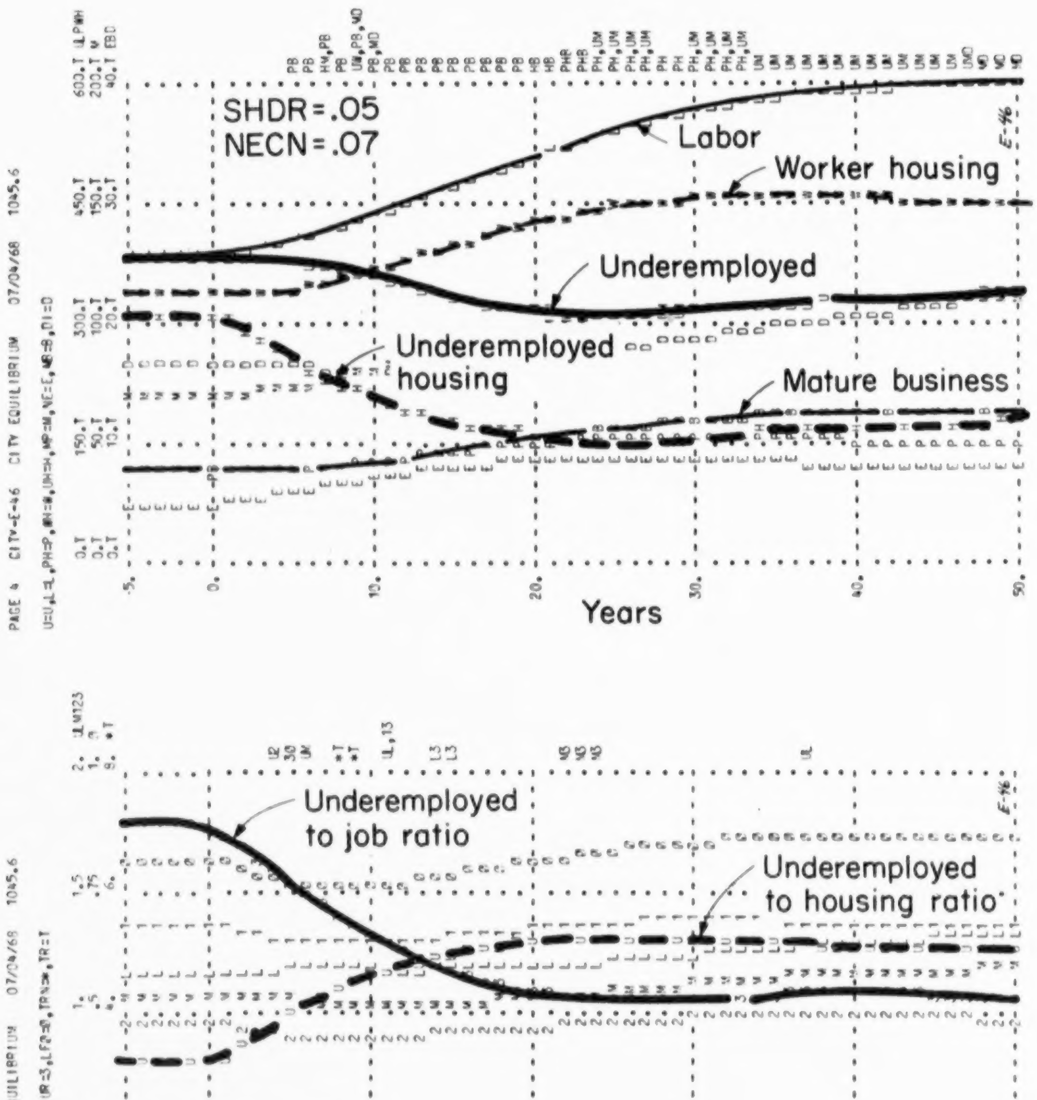
The detrimental changes over 50 years that result from constructing low cost housing each year for 5 percent of the underemployed.

clearly left them in a worse state as well as having dragged down the entire condition of the city. The responses in sectors of a complex system remote from the action taken are illustrated by the underemployed-to-job ratio which is the variable with the largest and most immediate response in the system. Construction of housing might have seemed unrelated to the creation of unemployment. The conflict between short run and long run effects is illustrated in a minor way by the underemployed-to-job curve. Initially, after the inauguration of the low cost housing program, there is a drop in the level of unemployment caused by the labor needed to create the housing. But this dip lasts for only two or three years before the appeal of the housing itself and the image of the city created by the housing program have attracted more underemployed. The long term effects are depressing to the entire city economy which reacts unfavorably to the more tightly filled land area, the less favorable population balance, and the higher tax rate.

Figures 5a and 5b show a reverse situation created by the inauguration of two simultaneous programs. One of these is a slum demolition program removing 5 % per year of the underemployed housing. The second is not specific in the model as to its implementation but is an increase of 40 % in the attractiveness of the city for new enterprise construction. This could be generated by favorable tax laws, by establishment of industrial parks within the depressed areas of the city, and by urban policies which favor business and the kinds of residential construction which will attract managers and skilled labor. Figure 5a shows a substantial rise in the skilled labor population and a smaller decline in the underemployed population. The result is a large change in the ratio of the two populations. Underemployed housing declines while all categories of business increase substantially. About 20 years is required to approach the new equilibrium.

Figure 5b shows a decline in the underemployed-to-job ratio from 1.8 to 1.1 which brings men and jobs approximately into balance. A necessary accompaniment to this has been the rise in the underemployed-to-housing curve from a state of excess housing to a crowded condition. As seen in Figure 5b the needed tax rate has declined. Much of the improvement in Figure 5 can be created by the slum demolition program alone with no change in business incentive. As the population becomes more balanced, a series of changes interact to cause the normal economic forces to start regeneration of the area.

The system model shows a high degree of insensitivity to such corrective action aimed at urban ills as underemployed training programs, job programs created by government, and tax subsidies to the city from the outside. In fact, according to this theory and model of urban interactions, a tax subsidy from the outside will soon result in increasing the tax assessment rate necessary from within the city.



Figures 5a and 5b

The revival of a city caused by demolishing 5 percent per year of the underemployed housing and increasing by 40 percent the inclination for starting new enterprise.

If planning in social systems is to be effective, it must deal with the internal mechanisms of such systems. It must start by under-standing why the existing difficulties are being created. It should aim not at alleviating symptoms but at changing causes. It should focus not on massive programs of expensive action but on the pressure points where small and low cost changes will release the internal forces of the system to generate its own improvement.

LONG–RANGE PLANNING THROUGH PROGRAM BUDGETING

by

David NOVICK (1)

with an Annex by Alain C. Enthoven (2)

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A plan for an organization, whether a government agency or a business firm, prescribes actions to be taken and activities to be carried on in the future to advance the organization's perceived objectives. Plans vary widely in substance and form according to the nature of the organization, the scope of the plan, and the time-frame to which it is applied.

One element is universal in the planning activities of any organization. At some point, it deals with the question, " How shall we make use of our available resources ? " This – the resource allocation question – is fundamental, because in every sphere of the organization's activity the amount of resources sets limits to what can be accomplished.

The strategic and most comprehensive form of planning is long-range planning of the organization's total program. In business, such planning may comprehend the full set of product lines and productive functions of a diversified corporation. In government, it may encompass the programs of an entire Department or Ministry or, perhaps, the development of a " Five-year Plan " for an entire jurisdiction. This paper deals with a system for organizing the long-range planning function and for assisting managers in reaching the key resource allocation decisions that confront them in this long-range planning context.

For more than twenty-five years I have been developing a management tool – Program Budgeting – which is designed to strengthen an organization's capability to do long-range planning and to provide a systematic method for resolving major resource allocation issues (1). Program Budgeting – or the Planning-Programming-Budgeting System abbreviated as PPB – focuses on the basic function of management, which is to use the organization's available resources in the way that will be most effective in meeting its goals. Basically, the PPB system contributes to the planning process in two ways.

First, it establishes and makes explicit the relationships, or linkages, among the organization's objectives, its programs and activities, the resource implications of those activities, and their financial expression in a budget. In doing so, it provides much of the information needed for rational planning in an easily usable form.

Second, PPB contributes directly to management decision-making by providing analyses of the consequences, in terms of estimated cost and expected benefits, of possible program decisions.

(1) Novick, D. (ed), introduction to *Program Budgeting : Program Analysis and the Federal Budget*, 2^{nd} ed., Harvard University Press, Cambridge, Mass., 1967.

While this may sound like a very broad charter, it should be borne in mind that there are a number of important things that PPB does not do : One is that PPB, as it is discussed here, is an instrument for overall planning which utilizes existing systems for directing and controlling operations and therefore does not necessitate change in either existing organization or methods of administration. Second, PPB is specifically designed for long-range planning and budgeting ; it is not primarily a tool for conducting the annual budgeting-accounting cycle, although next year's budget must be included in its purview and accounting supplies part of the reports. Third, although PPB stresses the use of quantitative analytical methods, and in some cases a rather extensive use of modern computer technology, it does not attempt to quantify every part of the problem or to computerize the decisionmaking process (1) .

Today, PPB has been in operation for seven years in the U.S. Department of Defense. In that time it has become part of the fabric of decisionmaking and management of U.S. national security programs. However, the system itself has not been static, but has changed significantly since it became operational in 1961 and continues to evolve today as a result of accumulating experience. (Further information on the PPB system in DOD and on the Department's experience in using it is contained in remarks by Alain Enthoven, appended to this paper as Annex A.) Since 1965, efforts have been under way to extend the PPB approach to other departments and agencies of the U.S. Federal Government. Many state and local governments in the U.S. have taken action to apply PPB methods to their own planning problems and analogous methods are in use in some major business firms. Most of the efforts in nondefense areas of government are now in preliminary or intermediate stages, as they need to overcome a variety of problems not encountered in the military arena. But collectively, they are providing a rich body of experience on the application of analytical planning techniques to social problems.Outside the United States, the Governments of Canada, Belgium, Israel, Japan, and Germany have either initiated pilot efforts in this field or are giving serious thought to the possible application of program budgeting. In addition to these total government efforts, the Defense Departments of the United Kingdom, the Netherlands, and others have undertaken program budgeting efforts.

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(1) Novick, D., *The Role of Quantitative Analysis and the Computer in Program Budgeting*. The Rand Corporation, P-3716, Santa Monica, California, October 1967.

Nevertheless, in some organizations the advent of PPB has caused much apprehension and insecurity. This is largely the result of misunderstanding of what PPB is and what it does. When understood and in operation, the Planning-Programming-Budgeting System turns out to be just common sense and simple. Perhaps because people assume it to be revolutionary and complex, it is usual that only in doing program budgeting does the real content come through — it is revolutionary but simple.

THE PROGRAM BUDGET CONCEPT

A few basic concepts provide the main elements of which the PPB system is constructed :

Objectives are the organization's aims or purposes, which, collectively, define its *raison d'être*. They may be stated initially in broad and relatively abstract terms, as for example, when we say that the objective of a defense program is to provide national security or the objectives of education are to provide good citizens and productive participants in the economy. However, objectives at this level are too remote from the organization's specific activities to be useful for formulating or evaluating programs. They must be translated into lower-level objectives that can be stated in sufficiently concrete terms to be operational.

Programs are the sets of activities undertaken to accomplish objectives (1). A program generally has an identifiable end-product. (Some programs may be undertaken in support of others ; if so, they have identifiable intermediate products.) Several programs may be associated with an objective, in which case they may be identified with distinct sub-objectives or with complementary, but separable, means for accomplishing the objective.

Resources are the goods and services consumed by program activities. They may be thought of as the inputs required to produce each program's end-product. Program *cost* is the monetary value of resources identified with a program.

Effectiveness is a measure of the degree to which programs accomplish their objectives. It is related to *benefit*, which is a measure of the utility to be derived from each program.

Program budgeting for an organization begins with an effort to identify and define objectives, and group the organization's activities into programs that can be related to each objective. This is the revolution, since it requires grouping by

(1) Novick, D., Anshen, M., and Truppner, W.C., *Wartime Production Controls*, Columbia University Press, New York, 1949, pp. 109-111.

end-product rather than by administrative organization or by function. This is done so that we can look at *what* we produce — output — in addition to *how* we produce or what inputs we consume. The program budget itself presents resources and costs categorized according to the program, or end-product, to which they apply. This is in contrast to the traditional budgets found in most organizations that assemble costs by type of resource input (line item) and by organizational or functional categories. For example, Tables 1 and 2 show proposed program budget categories for the U.S. Department of Transportation and for the education programs of the Department of Health, Education, and Welfare. The point of this restructuring of budget information is that it aids planning by focusing attention on competition for resources among programs and on the effectiveness of resource use within programs. The entire process by which objectives are identified, programs are defined and quantitatively described, and the budget is recast into a program budget format, is called the structural phase of Planning-Programming-Budgeting.

Often, both in government and in business, responsibility for the work required to accomplish a coherent set of objectives is divided among a number of organizations. In the U.S. Government, for example, programs with objectives for health and education are each fragmented among a dozen bureaus and independent agencies. The activities of each one are sometimes complementary, sometimes contradictory or conflicting with those of the others. But in any case, under traditional budgeting systems, planning for these programs tends to reflect their fragmented organization. There is no overall coordination of the resource allocation decisions relevant to program objectives. One of the strengths of program budgeting is that it is capable of cutting across organizational boundaries, drawing together the information needed by decisionmakers without regard to divisions in operating authority among jurisdictions. The advantage for planning is obvious : A program can be examined as a whole, contradictions are more likely to be recognised, and there is a context — otherwise lacking — for consideration of changes that would alter or cut across existing agency lines.

One product of the structural phase is a conversion matrix or " crosswalk " from the budget in program terms to the traditional or functional budget which treats organizations as though they were departments and sections in categories such as wages and salaries, supplies, equipment, etc. Through the crosswalk we are able to translate on-going methods of record keeping and reporting into data for program planning. Through it we are also able to translate program decisions into existing methods for directing, authorizing, controlling, recording, and reporting operations. If existing management methods in any of these areas are inadequate or unsatisfactory, they should be upgraded and improved whether

Table 1

AN OVERALL TRANSPORTATION PROGRAM

- General Inter-city Transport
  - Interstate Highways
  - Domestic Water Transport
  - Aviation
- Improve Rural Access
- Urban Commuter Transportation
- Military Standby Transportation
- International Trade and Prestige
- Regulation

Table 2

EDUCATION PROGRAMS OF THE DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

- Development of Basic Skills and Attitudes
- Development of Vocational and Occupational Skills
- Development of Advanced Academic and Professional Skills
- Individual and Community Development
- General Research
- General Support

or not the organization has a PPB system. In any case, the Program Budget must derive information and relationships from existing management records and practices and must rely on them for the implementation of the programs that are to be put into operation.

The long-range planner encounters problems of choice at several levels. At the highest level, the different programs and objectives compete for their shares of the organization's total resources or total budget. For example, in a government Transportation Ministry, there is competition among programs for international transportation, domestic intercity transportation and local transportation. In a business firm, there may be competition for investment funds among different product lines, different research and development projects, and so forth. At a lower level, the problem of choice focuses on decisions among alternative ways of carrying out a program. For instance, in connection with the Transportation Ministry's program of domestic intercity transportation, choices have to be made among alternative transport modes – railway, automobile, and air transport – or among alternative combinations of modes.

In program budgeting, the approach to this problem is to apply analysis wherever it is possible, so that decisionmakers will be able to make the final judgments with as much objective information as can be assembled. Thus, a Planning-Programming-Budgeting system subsumes a systems analysis capability, with which the resource and cost implications of program alternatives and their expected "outputs" or accomplishments may be estimated.

A major component of the analytical part of the system is *resource analysis*. This term comprehends an array of analytical concepts, cost estimating methods and data handling procedures that are used to estimate or predict the resource and financial implications of programs. A complete resource analysis capability : provides guidelines for characterizing or specifying programs with the concreteness needed for analysis ; includes the quantitative tools for translating program specifications into estimates of resource requirements and cost ; and – especially important – provides means for examining the impact of resource requirements on the program and the cost of changes or perturbations in program characteristics.

Usually, program resource estimates are produced with the aid of a quantitative resource or cost model. Such a model is built around a set of empirically-derived relationships between specific program parameters and specific elements of program cost. Often, the synthesis of such relationships calls for statistical or econometric estimating techniques and — so that they can be applied in a meaningful way — a considerable body of knowledge on the part of the analyst of the design of systems involved in carrying out the programs.

In many cases, there are strong interdependencies among the different resource-using activities of an organization. For example, two programs may make joint use of certain facilities or other resources, or certain " supporting " programs may provide services to two or more " direct " programs, or there may be technological interactions between the systems used in two or more programs. In these cases, it is necessary to look at a " total system cost ", for which the total system is defined with sufficient breadth to encompass all these interactions. To do this, it may be necessary to construct a total program resource and cost model that takes in the full range of activities of an agency or even a multi-agency complex that operates a government program. This global outlook is especially necessary where there are large joint cost items (e.g., as in providing the physical plant to house a variety of education programs or the launching capability to carry out a variety of space missions), for without it, it becomes difficult to do proper planning for the jointly used fractions of program resources.

In principle, the purpose of *effectiveness analysis* is parallel to that of resource analysis : to translate program characteristics into estimates of program output, effectiveness, or benefit. But in most areas of interest — though with certain localized exceptions — it is not possible to construct effectiveness measures that are adequate, or even when there are such measures, it is usually not possible to derive parametric relationships between them and the program specifications. That is, the state of the art in effectiveness analysis is far behind the state of the art in resource analysis in most areas of interest.

Because it is rarely possible to quantity fully all the elements of program cost or effectiveness and because it is difficult, in any case, to conceive of a rigorous analysis that could really comprehend all factors relevant to a major program decision, much of the effort of the analyst goes into setting up appropriate and revealing comparisons for the decisionmaker. The goal is not to make the decision analytically but to do what is possible to aid the judgment of the manager in whom the responsibility for decision resides. Thus, the analyst tries to identify the essential choices, to construct relevant alternatives, and to quantify and estimate those aspects of the cost and effectiveness of each alternative that yield to analytical techniques. He does not attempt to replace the decisionmaker ; rather, his role is to provide information that will let the decisiomaker focus on the real issues and that will sharpen the decisionmaker's judgment.

An important aspect of systems analysis in connection with program planning is that it often goes far beyond the decision problem as initially given. Program analysis is not confined to examination of predetermined alternatives. Development of new and better alternatives is part of the process. It is likely that analysis of possibilities A, B, and C will lead to the invention of new alternatives D and E, which may be preferable (more cost/effective) to the original candidates. Therefore, the analytical aspect of PPB cannot be viewed merely as the application of a collection of well-defined analytical techniques to a problem. The process is a much more flexible and subtle one, which calls for creativity by the analyst and interaction between the analyst and the decisionmaker during the decision process.

OTHER IMPORTANT FEATURES

I will briefly mention some other features of the PPB system in order to convey a *fuller* impression of the context in which these principles are applied :

Extended Time Horizon. Since program decisions that we make today often have implications that extend far into the future, and since program costs may be incurred and benefits received many years after a decision is made, meaningful planning requires a long time horizon. Generally, the program budget itself and the associated program analyses cover at least a five-year period and, where appropriate, they should be extended ten or fifteen or more years into the future.

Planning, not forecasting, is the purpose of the PPB system. Our aim is to examine the cost and benefit implications of relevant alternative courses of action for the future. The program budget, or Multi-year Program and Financial Plan as it is most formally referred to, conveys a projection of existing programs and a display of the resource and financial programs of decisions already made. However, it should not be thought of as a static extrapolation of a program, but as a kind of status report at one stage in an unending iterative process. At any time, the current Program and Financial Plan answers the question, " What would happen if we continue for the next five years with our current policies and current means for implementing them ? " The answer provides a baseline and frame of reference for formulating and examining proposals for improvement. It provides the base case from which incremental costs of proposed alternatives can be projected and against which accomplishments of alternative programs can be compared. When new programs are adopted or old ones terminated, the program budget is updated and the revised version becomes the base case for future planning cycles.

Comparability rather than accuracy is the main consideration in our analysis of program cost and benefits. Because of intrinsic uncertainties in long-range planning, absolute accuracy is, in any case, not attainable. The relevant criterion for analyses is consistency in treatment of different alternatives. This must be accompanied by explicit treatment of uncertainties, including tests of the sensitivity of analytical results to variations in circumstances. Excessive concentration on absolute accuracy is likely to be self-defeating since it would tend to overwhelm the work with detail and make this kind of planning impracticable. A corollary is that aggregate, not detailed, data, is generally used in cost and benefit estimation. Excessive detail makes examination of many alternatives costly or impossible, so we abstract from detail where we can and focus on variables that have important impacts on program consequences.

Several points may be made about the cost concepts that enter into program analysis :

Full costing of programs and program alternatives is required if we are to achieve the needed consistency in our estimates. Programs often have indirect cost implications that are difficult to trace. There may be important interdependencies between " direct " and " support " programs or among direct programs themselves (e.g.. joint cost situations). In order to sort out the full cost implications of alternatives, it is usually necessary to translate the total program of the organization into its resource and cost implications. The cost figures that will actually be compared with benefit estimates are *incremental costs* associated with specific program decisions. But these must be derived by comparing the full costs of an alternative with either another program alternative or a base case.

Resources and costs are generally divided into three categories, corresponding to differences in the time pattern by which they are incurred and in the duration of their contribution to benefits. *Research and Development* costs are the one-time outlays to create new capability, e.g., studies of new products, services, or technologies, or of new methods for accomplishing programs. *Investment* costs are the nonrecurring outlays required to install new capability, e.g., construction of plants or facilities, purchase of equipment, training of personnel for participation in new programs, etc. *Annual operating* costs are the recurring costs required to operate either new capability to be installed or existing capability to be kept in use. Each of these elements of cost enters into the full cost of a program. All three elements are projected on a year-by-year basis and summed for each program and for the total program of the organization. Capital and operating cost implications of programs are looked at together, not separately as is the traditional practice in the budgeting of many governmental agencies and business organizations.

A planning-programming-budgeting system provides for communication between analysts and decisionmakers and between analysts, operating organizations and decisionmakers at different organizational levels. Some of the specific documentary forms that have been developed to facilitate this exchange of information are the following :

Program Memoranda provide the communication between the analysts within a program area and the analytical staff which services the decisionmaking group. In these paper studies the program group lays out the issues it identifies in the program area, the alternatives it recommends, and the pros and cons for its recommendations, as well as the data, analysis, and arguments for the possibilities it has rejected.

The top-side analytical group re-analyzes the program memorandum and writes its program memorandum in response. The reply may accept the recommendations for the same, different, or modified reasons. It may determine issues that have not been raised. It may suggest alternative program packages that have not been considered. It may modify alternatives that were examined. After as much study, analysis, and re-analysis as time permits, the top staff, with concurrence or objection from the program manager, drafts the final program memorandum covering all issues and all alternatives for consideration by the decisionmaker.

Special Studies require more time and/or study resources than are available during the program memorandum period as scheduled. These areas are assigned for completion in the near future as the importance of subject indicates and will frequently (not always) cut across areas handled by two or more program managers. For reasons of time or specialized knowledge, parts or all of these studies may be contracted out.

Program Change action is another administrative step calling for analysis and study. Program Budgeting aims at a continuing, fluid management process. This means setting up a " base case " or set of decisions taken now which are revised and updated as required. When change is or appears to be in order, the program change considers the proposed change and does so in a total resource, overall time context just as though it was a program memorandum in the original deliberations.

Ideally, this would mean only one overall Program Budget exercise. Changes would be made as required and the revised total program plan that resulted would now become the new base case which would be used for the " crosswalk " from the Program Budget into the immediate changes in the budget as well as next year's organizational and functional operating budgets.

INTRODUCING PPB

Two possible courses of action are open for the introduction of Program Budgeting. One is to set up a study group which would examine the government's or company's objectives, develop a program structure tailored to those objectives, recommend alternative organization and administrative schemes, examine the organization's analytical capabilities and recommend education, training, and hiring policies to be followed in developing the analysis capacity required for Program Budgeting. (Reassignment, upgrading, etc. would obviously be included). This approach would aim at an operation to start 18 months to 2 years in the future.

The other way to proceed would start with the assumption that Program Budgeting is the thing to do and get on with it. This would mean taking some "great leaps" to put it in use in a current planning and budget cycle, and learning in the doing the answers the study group would otherwise have provided.

To do this, one would start by :

A. Setting up a program structure that uses major activities or lines of business as ***Final Product Programs***, taking major government agency-wide or company-wide activities such as electronic data processing (EDP) and calling them *Major Support Programs* and putting everything else, such as research, planning, executives, etc., into a *General Support Program* category. This may or may not be the right program basis. It probably is not. However, it will fit existing practice and is a satisfactory starting point from which improvements can be developed over time.

B. Having several Final Product Programs and Major Support Programs made the subject of *Program Memoranda* to be completed in 6 to 8 weeks. In developing the final product programs or major support programs, use is made of the existing analytic capability. The development of the program memoranda and the other communication materials of the program budget places high reliance on analysis. Therefore, if the analytic organization is either understaffed or inadequate, immediate steps should be taken to expand and upgrade.

C. Designating an individual(s) to complete the program structure so as to accomodate all of the government unit's or business unit's activities in A above. These studies should be completed in 8 to 10 weeks.

D. Designating an individual(s) to develop a first-cut study on alternatives available for organization and administration of Program Budgeting in the government unit or the business organization.

E. Agreeing on :

1. Program identification ;
2. Possible program manager ;
3. Organization and administration ;
4. Schedule of steps to be taken and dates ,

F. Getting executive approval and moving on.

One of the major advantages of this approach is that from the outset we get the required interaction between the operating, analytical, and decisionmaking parts of the organization essential to the development of an effective program budgeting system. By this device, time is saved and more intimate knowledge of the content of the administrative procedure is developed by both analytical and operating personnel.

CONCLUDING REMARKS

Let me conclude with a few words about the use of the word budget in " Program Budgeting. " Earlier I said " PPB is specifically designed for long-range planning and budgeting ; it is not primarily a tool for conducting the annual budgeting-accounting cycle, although next year's budget must be included in its purview and accounting supplies part of the reports. " The relationship between program and budget, and planning, programming and budgeting merits more complete description.

It is quite commonplace in the literature on budgeting for business to say, " the budget is the financial expression of a plan. " Many people apply the same definition for government. Nonetheless, we are all familiar with the budget that was developed without a plan (particularly a long-range plan). In fact, it is probably fair to say that in most budgets such planning as there is, is a projection of the *status quo* with increments added on the basis of the most current experience. Turning to the other side of the coin, we all know of plans that never get translated into budgets. A statement made by Roswell Gilpatric when he was Deputy Secretary of Defense in 1961 typified one of these situations : " In the past, the Defense Department has often developed its force structure by starting with a budget and sending it off in search of a program " (1). The other side is the elaborate plans made by either government or business which never get beyond the " top-level " approval ; that is, are never budgeted.

In summary, let me define *Planning* as the production of a range of meaningful potentials for selection of courses of action through a systematic consideration of alternatives. In the short range it deals with a limited number of alternatives because past actions have already locked in the available paths of action. However, for the long range (the major emphasis of Program Budgeting) the planning activity attempts to examine as many alternative courses of action as appear to be feasible and to project the future course of the organization against these in cost-benefit terms. Since the objective is not to make specific decisions but rather to turn up likely possibilities, the work is done in a general and highly aggregative form for both resources required and benefits to be gained.

Programming is the more detailed determination of the manpower, equipment and facilities necessary for accomplishing a program – feasibility testing in terms of specific resources and time. In *Programming*, the program and program elements used in the planning process in highly aggregative terms are moved down the scale to more detailed terms (as detailed as appropriate to the issue) required for determining the feasibility of the possibilities that are given serious study. Even here, for most cost elements, we are at a level of aggregation above that required for the detailed determinations that are involved in next year's budget. That budget is the translation of program cost elements into the specific funding and time requirements identified in traditional terms such as object class, function and organization.

The last few lines will be devoted to a further effort to distinguish the program budget from the traditional next-year's budget. PPB is the development and preparation of a budget in a planning context , that is, done with information about what is in store for the future. The planning context puts it in contrast to the short-range fiscal management and expenditure control objectives which categorize the traditional approach. This new method allows the design of major shifts among purposes for which resources are to be used, ranging from changes in funding levels to the introduction of completely new activities.

(1) Gilpatric, Roswell L., " Defense – How Much Will it Cost ? " *California Management Review*, Vol. V., No. 2, p. 53.

Under the program budget, annual allotments of funds to administrative organizations allow them to take the next step along a path the general direction of which has been thoughtfully set by policy makers at all levels. Probably more important, the direction of the path and the distance to be covered in the next year will have been established after considering a number of possible futures for the entire company or business organization.

ANNEX A

Additional information on Program Budgeting in the Department of Defense and the department's experience in using PPB, as represented by selected remarks of Dr. Alain C. Enthoven, Assistant Secretary, Systems Analysis, U.S. Department of Defense.

SOURCE : Planning-Programming-Budgeting, Hearings before the Subcommittee on National Security and International Operations of the Committee on Government Operations, United States Senate, Ninetieth Congress, First Session, Part 2, September 27 and October 18, 1967.

Before 1961, Defense budgeting and the planning of the strategy and forces were almost completely separate activities, done by different people, at different times, with different terms of reference, and without any method for integrating their activities. Forces and strategy were developed by the military planners ; budgeting was done by the civilian secretaries and the comptroller organization.

The strategy and force recommendations of the Military Services and the Joint Chiefs of Staff were developed, for the most part, without any explicit reference to costs. Systematic information on the full financial costs of alternative strategies or forces was not available.

The Defense budget was based on a predetermined financial ceiling. This ceiling was in turn based on judgments about the nation's capacity to pay, but without explicit reference to military strategy or requirements. Systematic information on the implications for strategy or forces of different budget levels was not available.

If bought and fully supported, the forces recommended by the Services and the Joint Chiefs of Staff would have cost much more than the Administration was willing to pay. This is not surprising or unusual. The bargaining process by which the recommended forces and the budget ceiling were reconciled, however, led to serious problems. As the budget examiners bore down to meet their predetermined targets, the Services held on to their force structures and their most glamorous weapon systems. What normally gave way were the less glamorous support items : ammunition and equipment inventories, support personnel, spare parts, etc. The result was unbalanced forces that could not have been readily deployed into combat. The glamorous weapon systems had been retained, but at the cost of reducing important items of supply to a few days or weeks.

Military planning was done in terms of missions, weapon systems, and forces – the " outputs " of the Defense Departement. Budgeting was done by object classes or appropriation titles – Procurement, Operations and Maintenance, Military Personnel, Research and Development, and Construction – the " inputs " to the Department. There was no machinery for translating appropriations into the forces or missions they were to support. Thus, it was not possible for the Secretary of Defense, the President, or the Congress to know in meaningful terms where the Defense dollars were going.

What PPBS is and is not

First and fundamental is the fact that since 1961, the Secretary of Defense has not operated with any predetermined budget ceiling. Rather, he judges each proposal on its merits, considering the need, the contribution of the proposal to increased military effectiveness, and its cost in national resources. The total Defense budget recommended by the Secretary of Defense to the President, and by the President to the Congress, is the sum of many such judgments about military need and effectiveness and their relation to cost.

While it is inevitable that many will disagree with the Secretary of Defense on specific decisions, it seems clear to me that this is the most rational and balanced way to approach the Defense budget. Moreover, I believe the Secretary of Defense sits in the best place to make such judgments, subject, of course, to review by the President and the Congress.

I recall the reaction by a friend of mine, then in Programming in the Joint Staff, to the first presentation by Mr. Hitch of the principles of PPBS : " Good. From now on, whenever the Secretary of Defense wants to cut the Army's budget, he will have to name the units. " That is true, and as it should be. Of course, this approach makes great demands on the Secretary of Defense because it forces him, with the help of his staff, to become acquainted in detail with the merits of many proposals. It gives the Secretary of Defense a lot of homework to do. It is clearly much tougher than simply decreeing across-the-board cuts based on some arbitrary financial limit.

To consider these proposals, the Secretary must have a systematic flow of information on the needs, effectiveness, and cost of alternative programs, including differing opinions on them when they exist. We are organized to provide this information.

Second, decision making on strategy, forces, programs, and budgets is now unified. A decision to increase our forces or to start a new weapon system is a decision to add the required amounts to the financial plan. The machinery by which this is done is the Planning-Programming-Budgeting System.

The key to this system is decision making by missions, i.e., by the " outputs " of the Department of Defense rather than solely by the " inputs ".

We call the basic, mission-oriented building block of the programming structure a " program element ". A program element is an integrated activity, a combination of men, equipment, and installations whose military capability or effectiveness can be related to our national security policy objectives. For example, B-52 wings, infantry-battalions, and attack submarines, each taken together with all the equipment, men, installations, and direct support required to make them effective military forces, are program elements. The program elements are then assembled into " major programs " defined by mission. A major program contains closely related elements which must be considered together in arriving at high-level management decisions. For example, Strategic Retaliatory Forces, General Purpose Forces, and Airlift-Sealift Forces are major programs.

A program element has both costs and benefits associated with it. The benefits are the ways in which it helps us to achieve broad national security objectives. The costs include the total system cost, regardless of appropriation category, projected systematically five to ten years into the future.

PPBS enables the Secretary of Defense, the President, and the Congress to focus their attention on the major missions of the Department of Defense, rather than on lists of unrelated items of expenditure. For example, in making decisions about Strategic Retaliatory Forces, the Secretary looks at the threat, at our national objectives, and at alternative plans to meet our objectives, their effectiveness, and their costs. He reviews the data on these matters with the Joint Chiefs of Staff and the Services ; obtains their advice, and makes decisions on the forces. From there on, the breakdown of the budget by Service and appropriation title is largely derivative, a process left mostly to the staff.

The advice of the Joint Chiefs of Staff is systematically sought and included in this process. In particular, they now have cost data that enable them to estimate the financial implications of their force recommendations. Thus, force requirements and strategy are effectively related to costs early in the decision making process.

Each spring, the Joint Chiefs and the Services send the Secretary of Defense their recommendations on forces, together with supporting data. The Secretary reviews these recommendations, and, during the summer, sends the Joint Chiefs of Staff and the Services the results of his review in the form of memorandums – called Draft Presidential Memorandums. These drafts summarize the relevant information on the threat, our objectives, the effectiveness, and cost of the alternatives he has considered and his tentative conclusions. With rare exceptions the Joint Chiefs and the Services have a month to review and comment on each of these drafts. They comment in detail. The Secretary reviews the comments thoroughly. He revises his tentative decisions, has more discussions with the Chiefs and the Services, and gradually develops a program and a budget. This dialogue continues for months. It is in sharp contrast to the situation the Senate Preparedness Subcommittee found in 1959 :

" Furthermore, the Joint Chiefs as a group were given only 2 days to consider the total program and never considered such important aspects as the size of the Army, whether to include an aircraft carrier or — most fundamental of all — what deterrent forces are needed. "

The results of the process are summarized in the Five Year Defense Program. It includes an eight-year projection of all approved forces, and a five-year projection of costs, manpower, procurement, construction, etc. This document enables all top Defense officials to be readily informed about the total Defense program and its components.

The decisions in the Five Year Defense Program do not represent a five-year commitment by the President or even by the Secretary of Defense. Nor do these decision " tie the President's hands. " The President and the Secretary of Defense retain their flexibility to change these decisions as they should. Rather, the Five Year Defense Program represents the sum total of programs that have been tentatively approved for planning purposes by the Secretary of Defense. You might say it is an official set of assumptions about what forces we currently plan to request anthorization for in the future, assumptions from which the financial planners can derive the budget requests required to support these forces.

Moreover, the Five Year Defense Program is not a complete master plan calculated in minute detail at the top and handed down to the troops for execution. It is a set of broad planning guidelines that help us all to pull together in the same direction instead of at cross-purposes. It is not a substitute for individual initiative or for the many benefits that we get from competition among and within the Services. The Planning-Programming-Budgeting System is not what makes the Departement of Defense run. The initiative, the drive, the imagination, the dedication, the judgment, and the hard work of a great many people, makes the Department of Defense run and progress. PPBS is a flexible tool to channel this creative energy, as much as possible, along rational and useful lines.

What Systems Analysis is and is not

Hardly a week goes by that I don't read some fantastic description of systems analysis in the Pentagon. The more I read about it in the public press, the more I get the feeling I must not be doing it. According to some accounts, the essence of systems analysis is the application of computers and fancy mathematics to reduce all issues to numbers, with lots of attention to cost and none to effectiveness, and with a complete lack of interest in military judgment or anyone else's judgment. If I believe that even a small fraction of such descriptions were accurate, I would recommend to Secretary McNamara and Deputy Secretary Nitze that they fire me ; I am sure that if they believed I was trying to replace their judgment with a computer, they would not wait for my recommendation.

In fact, systems analysis is just one name for an approach to problems of decision making that good management has always practiced. The essence of systems analysis is not mysterious, nor particularly complicated, nor entirely new, nor of special value only to Defense planning. Rather, it is a reasoned approach to highly complicated problems of choice characterized by much uncertainty ; it provides room for very differing values and judgments ; and it seeks alternative ways of doing the job. It is neither a panacea nor a Pandora's box.

Decisions must be made by responsible officials on the basis of fact and judgment. Systems analysis is an effort to define the issues and alternatives clearly, and to provide responsible officials with a full, accurate, and meaningful summary of as many as possible of the relevant facts so that they can exercise well-informed judgment ; it is not a substitute for judgment.

You might object, "But you're merely describing disciplined, orderly thought ; why call it 'systems analysis'? " Most labels are imperfect ; this one is no exception. We use the phrase "systems analysis" to emphasize two aspects of this kind of thinking.

First, every decision should be viewed in some meaningful context. In most cases, decisions deal with elements that are parts of a larger system. Good decisions must recognize that each element is one of a number of components that work together to serve a larger purpose. The strategic bomber, the airfield, the pilot, the fuel, and the spare parts are all parts of a weapon *system*. One cannot make sense out of airfield requirements without looking at the objectives the bomber is intended to achieve. For some purposes, it is necessary to look at the airfield construction program as such ; there would be no sense in building a new bomber base if a perfectly good transport base were being vacated a few miles away. Systems analysis emphasizes the airfield as a part of the weapon system. Similarly, to make sense of strategic bomber requirements, you need to look at other strategic offensive weapons, such as missiles.

There is nothing mysterious about this kind of thinking. Informed men in the Congress, the Executive Branch, and elsewhere have been pointing out the need for such an approach for years. We are doing it, and we have given it a name.

The word *analysis* is used to emphasize the need to analyze complex problems, that is, to reduce them to their component parts. Then each of the component parts can be studied by methods appropriate to it. Logical propositions can be tested logically ; questions of fact can be tested against the factual evidence ; matters of value and uncertainty can be exposed and clarified so that the decision makers can know exactly where to apply their judgment.

Systems analysis is not a substitute for judgment ; it is an aid to judgment. It helps by isolating those areas where judgment must be applied and by indicating to the decision maker the potential significance of each of the alternatives he might choose. Systems analysis is not a " wholly rational basis for decision making... (a) technocratic utopia where judgment is a machine-product ".

Far from it. It is based on the fact that most decisions in Defense are at least partly susceptible to rational treatment, and it tries to deal with these in a disciplined way, leaving the responsible decision makers more time to ponder the imponderables and weigh the intangibles.

One of the foundations of systems analysis in the Department of Defense is the concept of " open and explicit analysis. " Unfortunately this is not something that is discussed in the formal literature on analytical methods, but it is very relevant to the concerns of this committee. In fact, this concept is the single most important idea I have to communicate today.

An analysis is " open and explicit " if it is presented in such a way that the objectives and alternatives are clearly defined, and all of the assumptions, factors, calculations, and judgments are laid bare so that all interested parties can see exactly how the conclusions were derived, how information they provided was used, and how the various assumptions influenced the results. We do not achieve this in every case, but this is the objective, and important issues are almost always approached this way.

In other words, systems analysis is a method of interrogation and debate suited to complex, quantitative issues. Systems analysis is a set of ground rules for constructive debate , it gives the participants useful guidelines for proceeding to clarify and resolve disagreements. It requires the participants to make their methods of calculation and their assumptions explicit so that they can be double-checked ; it helps to identify uncertainties, makes these uncertainties explicit, and aids in evaluating their importance ; and it identifies and isolates issues.

Systems analysis is not an attempt to measure the unmeasurable. But one of the opportunities that systems analysis offers for creative work is seeking ways of giving valid measurement to things previously thought to be unmeasurable. A good systems analyst does not leave considerations that cannot be quantified out of the analysis. Inevitably such considerations will be left out of the *calculations*, but a good analyst will and does list and describe such factors.

Systems analysis is definitely not synonymous with the application of computers. We sometimes use computers, we also use pencils, paper, slide rules, telephones, etc. The computer aspect has been grossly over-played in many discussions of systems analysis. The use or misuse of computers is too minor an aspect of this subject to be relevant to the serious concerns of this committee.

" Cost-Effectiveness " Analysis and the Relevance of Cost

Some of the main tools of systems analysis come from Economics. Where appropriate, we approach problems of choice by defining the objectives, identifying alternative ways of achieving the objectives, and identifying the alternative that yields the greatest effectiveness for any given cost, or what amounts to the same thing, that yields a specific degree of effectiveness for the least cost. In other words, the main idea is to find the alternative that yields the greatest military effectiveness from the resources available.

Systems analysis includes a critical evaluation of the objectives. It recognizes that most ends are, in fact, means to still broader objectives. For example, an ability to destroy a particular target is not likely to be an end in itself , it is a means to some more basic end such as deterrence. Therefore, a good systems analyst will seek to determine whether or not the pursuit of certain intermediate objectives is the best way of pursing the broader ends.

Thus, systems analysis is often associated with " cost-effectiveness " or " cost-benefit " analysis. The term " cost-effectiveness " analysis is often misunderstood. It seems to suggest to some people a notion of " cost-effectiveness " that is somehow to be contrasted to " military effectiveness " or just plain " effectiveness ". It might be better if we used the expression " military effectiveness " in relation to cost, or simply " the best mix of military forces ".

The point is that every weapon system we buy has both benefits and cost associated with it. You cannot get " effectiveness " without paying a " cost. "

Each program uses up resources that could otherwise be put to some other useful purpose. Sensible decisions on the use of these resources must depend on the costs incurred in relation to the military effectiveness obtained. " Cost-effectiveness " analysis is nothing more than an attempt to identify the alternatives that yield the most effectiveness in relation to the money spent and other costs incurred.

Cost in any program merely represents " effectiveness foregone elsewhere. " The reason that the Secretary of Defense cares about the cost as well as the effectiveness of proposed weapon systems is because he recognizes that the dollars used to support a particular program represent resources that could possibly be used to greater benefit elsewhere. Cost and effectiveness must be related to achieve national policy goals, just as the front and rear sights of a rifle must both be used to hit the target. The position of the rear sight matters only in relation to the front sight. Likewise, the cost of a program matters only in relation to the military effectiveness provided, and *vice versa*.

Does " cost-effectiveness " analysis stifle innovation ? On the contrary, such analysis has given the proponents of good ideas a better way of making their case and of getting prompt and favorable decisions. I would cite, as example, such new systems as the Minuteman II, Minuteman III, and Poseidon strategic missile systems , Multiple Independently-targetable Re-entry Vehicles (MIRVs) that enable one ballistic missile to destroy many separate targets ; the Short Range Attack Missile known as SRAM ; the Sprint and Spartan anti-missile missiles and the new phased array radar that will guide them , the A-7 fighter bomber ; the C-5A transport aircraft ; the Fast Deployment Logistic Ships ; and the Airmobile Division. In each case, some very good ideas were identified early and sold on the basis of " cost-effectiveness " analysis. Also, by helping to cut back programs that are based on poor ideas, " cost-effectiveness analysis " helps to leave more resources available for the most effective programs.

Does " cost-effectiveness " analysis always lead to a preference for the cheapest system on a unit cost basis ? The record shows it does not. I just mentioned a number of systems that were justified on the basis of " cost-effectiveness " analysis, each of which costs more per unit than its predecessor. However, in each case the margin of extra effectiveness per unit is worth the extra cost.

Achievements of PPBS in the Department of Defense

PPBS has led to a major and general improvement in the quality of the decision and planning process in the Department of Defense. It has also led to a major improvement in the quality and relevance of debate over requirements issues. The Secretary of Defense, the Joint Chiefs of Staff, and the Services have more and better data on the effectiveness and costs of alternative programs.

Many studies have been done, and others are underway throughout the Department on each major force requirement issue. Procedures have been established so that these studies can be followed and reviewed in an open and professional way by the Office of the Secretary of Defense, the Joint Staff, and the Services.

PPBS provides an official force plan which gives the planners and analysts in the whole Department a firm foundation for their planning and a solid point of departure for their analyses. Now the procurement, facilities, and personnel branches can be confident they are providing equipment, facilities, and manpower for the same forces, thus greatly reducing the confusion and waste that occurred when there was no unified, approved plan as the basis for these activities. Today we have a firm force structure base from which to analyze the additional effectiveness and cost of new programs. The left hand has a better idea of what the right hand is doing in force and financial planning.

By unifying programming and budgeting, PPBS has closed the " gap " between force and financial planning. This has led to the acquisition of ready, more balanced, and better supported combat forces. There have been the inevitable difficulties in detailed execution, and I do not doubt that one could find minor examples to the contrary. But, for the most part, since instituting PPBS, the forces that have been authorized and approved by the Secretary of Defense have been procured together with the manpower, equipment, facilities, etc., necessary to make them balanced and combat ready. The systematic viewing of all requirements on an overall basis, rather than on the basis of a single Service, has led to the elimination of much unnecessary duplication.

PPBS and Politics

Is PPBS " technocracy versus politics ? " No. Is PPBS in conflict with political realities ? No. Is there a danger that PPBS might develop into a contest between experts and politicians ? I do not think so.

Your *Initial Memorandum* referred to the potential conflict between experts and politicians, and expressed the fear that PPBS was a scheme conceived by experts to take power from politicians. Insofar as there is conflict in our political system between the experts and the politicians, I believe that PPBS is on the side of the politicians. I would like to make four points to illustrate my belief.

First, one main purpose of PPBS is to translate the financial budget from detailed listings of objects of expenditure, whose purpose is not set forth for the generalist, into mission-oriented categories, whose broad purposes are set forth. Thus, PPBS has translated the Defense budget from procurement, operating expenses, manpower, construction lists, etc., into a breakdown by Strategic Retaliatory Forces, Continental Air and Missile Defense Forces, General Purposes Forces, Research and Development, etc. We have additional breakdowns under these headings by output-oriented weapon systems. The Congress quite rightly asked for and got this information so that its members could have a clearer picture of where the money was going.

One of the main purposes of systems analysis is to translate the lower level, detailed, technical criteria of the experts into broader , more general criteria of significance to the political leaders. Thus our studies in Strategic Offensive and Defensive Forces led to the translation of such factors as weapon yield, reliability, and accuracy into target destruction, and target destruction into lives lost and lives saved. Surely the number of lives saved by the expenditure of $ 10 or $ 20 billion on an anti-missile system is of greater significance to the politician than the " single-shot kill probability " of a Sprint missile against a re-entering Soviet warhead. Similarly, the number of division forces that can be deployed and closed in Europe, within 60 days, can be of much more significance to the politician than the ton-miles carried by our ships or aircraft. We now have these measures ; Secretary McNamara presents them to you in his posture statement. It has taken a lot of analytical effort to develop them.

Second PPBS is a response to requests from the Congress, particularly from this committee and from the House Appropriations Committee. This committee has been especially clear on this point. In 1961 it stated that budgets should be prepared " in such a way as to make the most useful in establishing priorities, in forward planning, in choosing between programs, and in measuring expenditures against meaningful performance yardsticks. "

Third, as I mentioned earlier, PPBS is not a substitute for debate. It is a way of making the relevant factors, issues, assumptions, and uncertainties explicit so that a constructive, useful debate can be held. Then the significant points of agreement and disagreement can be identified and their importance assessed in a systematic way. In fact, I believe that effective systems analysis requires stimulation and testing by debate, and that one of the most important contributions that systems analysis has made to the operation of the Department of Defense has been to provide ground rules and procedures for making the debate on strategy and requirements more factual, informed, and relevant.

Fourth, your *Initial Memorandum* states : " The experience to date does not suggest that the Department of Defense is likely to place before Congressional committees the analyses of costs and benefits of competing policies and programs on which the Department based its own choices. " That is not true. The record shows that Secretary McNamara has clearly and explicitly displayed the major alternatives considered and an evaluation of them in his testimony to the Congress on major issues. To document this, I am attaching to my statement, as an Appendix, a series of unclassified excerpts from the statements of the Secretary of Defense, over the last several years, showing his explicit treatment of the alternatives in anti-missile defense, our bomber force, and other issues. Many more examples can be found in the classified and unclassified versions of his statements.

Summary

Let me now summarize briefly.

First, before 1961, several committees of the Congress, including the one before which I have the honor of appearing today, justly criticized the budgetary process in the Department of Defense because :

(1) it was based on arbitrary and predetermined financial limits unrelated to military strategy or needs ;

(2) it was done entirely by objects of expenditure which were unrelated to the missions of the Department of Defense ;

(3) it was a piecemeal, one-year-at-a-time-effort, without adequate attention to long-run consequences ; and

(4) it paid insufficient attention to measures of performance or effectiveness.

Since 1961, we have developed a Planning-Programming-Budgeting System in the Department of Defense that :

(1) starts with a review of strategy and military needs, develops a program to meet them, and derives an annual budget without regard to predetermined financial limits ;

(2) is based on a financial plan that identifies Defense spending by the major military missions subdivided into meaningful " output-oriented " program elements ;

(3) projects forces eight years into the future, costs at least five years (and to completion for major systems) ; and

(4) focuses attention on explicit measures of effectiveness.

For the very reasons that the Congress called for these reforms, I believe that they enable us to manage the Department of Defense better.

Second, open and explicit analysis, reviewed and commented on by all interested parties is fundamental to the working of PPBS in the Pentagon. No major force issues are decided by the Secretary of Defense on the basis of analysis by any one office or department alone. The analyses underlying the Secretary's decisions are circulated for comment and review by all interested parties, and their comments go directly to him. The procedures are designed so that the Secretary will hear all sides, so that no one has a monopoly on the information going to the Secretary. This open and explicit approach is our best protection against persistent error ; it makes it virtually impossible for any group to rig the analysis without that point being made clear to the Secretary. It ensures that all assumptions are made explicit and that all opinions are considered.

Third, systems analysis is an integral part of PPBS. Systems analysis is not synonymous with the application of mathematical techniques or computers. Systems analysis is not a substitute for judgment ; it is an aid to judgment.

" Cost-effectiveness " analysis does not lead to an over-emphasis on cost. It does not stifle innovation ; on the contrary, it helps it. It does not always lead to buying the cheapest system ; there are numerous examples to the contrary. " Cost-effectiveness " analysis does not lead to an overemphasis on factors that can be reduced to numbers ; on the contrary, good systems analysis frees the decision maker to concentrate on the intangibles and uncertainties.

Fourth, PPBS bas not led to a single set of assumptions dominating military strategy ; it has not led to a single, rigid military strategy ; it has not eliminated flexibility ; and it has not over-centralized the Defense decision making process. On the contrary, PPBS in the Department of Defense has been associated with a change from the inflexible strategy of " massive retaliation " to a strategy of " flexible response. " Moreover, it has been associated with large increases in our military strength to give us the balanced, ready forces we need to support this strategy.

Fifth, the potential of PPBS is great in clarifying debate over program issues, in stimulating and recognizing new solutions to problems, and in helping the Government to spend money wisely. Within the limits of what any improvement in management can do, I believe that PPBS has the potential to be a most important innovation in government management.

Let me close with a story which perhaps makes one of the basic points about PPBS. In the early 1960s, I was invited to address the cadets at West Point. After my talk which was an explanation of what we now call PPBS, Colonel G. A. " Abe " Lincoln, the distinguished Head of the Department of Social Sciences, came up to me and said :

" You know, Alain, you aren't doing anything *new*. You're just applying the principles of rational decision making we've been teaching for years. The only difference is that you're *doing* it. "

" You're right, Abe. We're *doing* it. And it isn't always easy. "

TOWARD INFORMATION SYSTEMS FOR ENVIRONMENTAL FORECASTING

by

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The opinions or conclusions expressed in this paper are those of the author and are not intended as expressions of the views of TEMPO or any other component of the General Electric Company.

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INTRODUCTION

As time passes, physical science and technology offer an ever increasing menu to whet the social appetite. We do not partake fully of this menu. Resource limitations and social priorities require that we make choices from among the offerings. We order some, defer some, and reject other options without fully understanding the way any particular pattern of choice influences the character of our future.

We are adept at organizing science and technology to increase and vary the current menu. We are becoming proficient in forecasting possible future menus or " technological decision agendas ". For these purposes we have consistently improved the quality of our planning tools. On the other hand, planning tools to assist in anticipating and shaping the quality of our environment lag in development.

Social choices or decisions sometimes rest primarily on scientific and economic criteria. More often, however, these decisions are political and require political criteria. In either event the decisions are the prerogatives of social institutions and often turn on criteria which may not be evident to the technologist nor consonant with his interests. Thus policy, along with technology, is an essential part of futurism, and the policy maker is central in shaping things to come.

A serious attempt is overdue to provide an explicit and scientific basis for policy planning, just as we have provided such a basis for generating the decision agenda and for planning the implementation of various technologies. To this end, analysis of the environment and the forecast of future environmental outcomes must be explicitly related to existing social policies and policy alternatives, respectively. Acquiring such a capability is a fundamental requirement for normative planning.

We can characterize the environment, present or future, as a set of outcomes, situations, or social conditions which is the policy consequence of the interaction of technology and social institutions. The purpose of environmental analysis is to establish the linkages among these outcomes and the institutions, policies and technologies which shape them.

Can such interactions be analysed and such relationships developed ? Can social policies be forecast ? Does " the environment " even exist as a single all-embracing concept ? This paper will examine such questions and set forth an interim approach to environmental forecasting.

THE ENVIRONMENTAL SYSTEM

The basic units of analysis of the environment are the institutions or actors which populate it. These actors are numerous, aggregative, and heterogeneous. For example we might crudely depict the system of actors in the world environment as in Figure 1.

In this figure the vertical axis separates intra-national actors on the left from international actors on the right along a scale of rising aggregation from left to right. The horizontal axis separates governmental (public sector) actors in the upper half of the figure from non-governmental (private sector) actors in the lower half. In general, the number of actors decreases but their social influence increases as the level of aggregation rises. The hierarchy of actors ranges in magnitude from several billion individuals to about one hundred and fifty nation-states to a handful of universal organizations. The inherent heterogeneity of these actors both across and within levels of aggregation requires no elaboration ; the policies of these actors, it must be noted, are equally heterogeneous.

In the figure, the linkages among the actors represent a network of direct paths for their interactions. There are, in addition to those linkages illustrated, direct interaction paths which are obscured in this two-dimensional model,i.e., paths between pairs of individuals, nations, states, etc... Furthermore, this network implies indirect interaction paths between actors ; e.g., an individual interacting with another through a sub-state actor, like a municipal court ; or a state interacting with another through a multi-nation actor, like the International Red Cross. If the total number of actors in the environment is of the order of billions, the total number of paths of interaction is, for practical purposes, infinite.

Clearly, all actions by all the actors depicted in this crude model do not significantly affect all other actors. Yet, when actors of higher levels of aggregation act, significant and widespread repercussions often occur. Needless to say, any attempt systematically to analyse the environment requires that attention be limited to a small (if not minute) fraction of the total actor-interaction milieu. Therefore such analyses run the risk of potentially serious errors of omission. This is an ever present problem in environmental analysis.

Functions of Actors

Let us examine the actors in our environment more closely. With the exception of the individual, all actors are organizational types which have

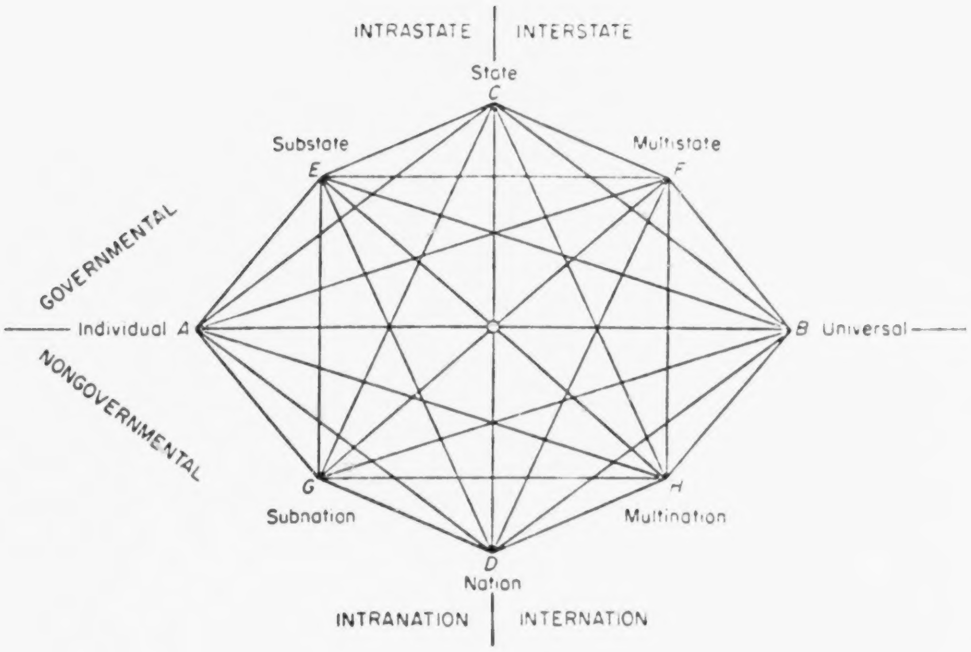
INTRASTATE
INTERSTATE
State
C
Substate
E
Multistate
F
GOVERNMENTAL
Individual A
B Universal
NONGOVERNMENTAL
G
Subnation
H
Multination
D
Nation
INTRANATION
INTERNATION

Figure 1 - Environmental Actors and Interaction Paths

evolved to perform basic social functions. Three functions may be discerned ; (1) organizing, (2) processing, and (3) connecting.

The organizing function is primarily one of setting goals, establishing and enforcing norms for actor behavior, and allocating resources. The processing function includes all transformation activities in society, e.g., fuel into energy, raw materials into products, sick people into well people, etc. Finally, the connecting function is one of providing the channels for interactions between and within actors.

Four points are of crucial importance in this societal view :

1. While all three functions may be identified in the internal structure and activities of each actor, in the context of an actor's external environment one of the three social functions will ordinarily dominate. For example, internally the General Electric Company has a management (organizers), shipping and communication channels (connectors), and manufacturing and personnel training activities (processors). But the external role of the company is identifiable as manufacturing or processing. On the other hand, the Congress is easily seen as performing an organizing function in U.S. society.

2. The actors or organizations which have evolved to serve society's functional needs represent the current state of the art of the technology of social systems – combinations of human resources and technology which perform society's functions. This view emphasizes the role of technology as a servant of society. At the same time it implies the potential of technology for reshaping the actors themselves and offers insight, therefore, into the conflict which can occur between the goals and interests of technology (and technologists) and those of society's organizations.

3. Actors which fulfil processing and connecting functions in society tend to be reactive to change (and to the future) since their social charters do not provide them with the decision prerogatives necessary for control of the external environment. These actors tend to evaluate their environment and anticipate the future with the strategic goal of adapting to it.

4. Actors who fulfil the organizing functions in society tend to be active. Influencing change is their social charter. These actors evaluate the environment and anticipate the future with the normative goal of influencing or controlling it.

Because technology is so pervasive a contemporary force for social change, the attention of organizing actors to its potential benefits and hazards has increased. The policies set by organizing actors influence the mix, rate of development, and rate of introduction of science and technology in society. It is this interaction of technology and policy in the organizing hierarchy of society which separates the " will " and " can " of operational and strategic planning, respectively, from the " ought " of normative planning.

Environmental Relevance

The environment has been described as the policy consequence or outcome of the interaction of society's actors and technology. This description suggests the nature of the environment but not its scope. We must now shift from a systemic view to an actor view of the environment.

From the point of view of any actor, the notion of *the* environment is a fiction. Each actor is interested in a different environment ; a particular set of outcomes related to a particular set of actors, technologies and policies ; a set of outcomes which bears directly on the actors' social function ; an environment which the actor can affect either through adaptation or control. For any actor this environment, and this environment alone, is relevant.

The ultimate test of this notion of relevance is whether the presence or absence of particular environmental information affects any decision made or action taken by an actor in the course of his social performance. On this basis it may be concluded that the totality of the environmental system (Figure 1) has relevance to no single actor. As a corollary, the relevant environment for any particular actor is equivalent to only a small part of the environmental system. This fact tends to reduce the potential for error by omission in environmental analysis, but places a responsibility on the actor to " know himself " so that he may know what environmental information is relevant to his social purpose.

INFORMATION SYSTEMS FOR ENVIRONMENTAL FORECASTING

Knowledge of the future environment implies the availability of forecasts or estimates of future environmental outcomes. It is convenient to describe the means by which such estimates are produced as Environmental Information Systems (EIS), even though the term information system connotes considerably more rigor in design and continuity of operation than are typical in the production of such estimates.

As a part of the explosive growth of futurism in the past five years, there have emerged four basic classes of EIS. These can be designated as " gratuitous ", " ad hoc ", " structural " and " comprehensive ". A gratuitous EIS is an unsolicited or voluntary outpouring of estimates of future environmental outcomes, usually based primarily on the intuitive expertise of one or a small number of authoritative individuals, and published in book or report form. An *ad hoc* EIS is a solicited compendium of estimates of future environmental outcomes, usually the result of a conference, commission or task force comprised of a relatively large number of authoritative individuals. The gratuitous or *ad hoc* EIS tends to focus attention primarily on the end product or forecast, and relies heavily on intuitive judgment and consensus as the means to produce the forecast.

A structural EIS is a detailed scenario leading to a possible future environmental outcome via a meticulously designated path of intervening outcomes and decisions. A comprehensive EIS consists of a set of boundary conditions and a predefined methodology or model for generating all possible outcomes within the stated boundaries. The structured or comprehensive EIS tends to emphasize the means for estimating rather than any particular forecast which emerges.

The future estimates obtained from all four classes of EIS are usually communicated with appropriate caveats, and are referred to as possible, plausible, or alternative futures as befits the case. But from a critical standpoint these four approaches generally share two shortcomings. First, they do not sufficiently represent the importance or strength of the policy function. As a result the forecasts are often of the following types : (1) the technological innovations which are likely to emerge regardless of policy, or (2) the estimated effects of technology on society. In neither case is policy accorded an active role, in which event outcomes would reflect the interaction of technology and society, or, perhaps more properly, the effect of society on technology. Second, the substance of the forecasts does not necessarily bear a relationship to the needs of their potential users. That is, the forecasts often dwell on outcomes which the EIS designers rather than users have selected as important.

It should not be denied of course that there is a purely informative or educational role for forecasts of the future. As such, the primary goal may not be future estimates which are relevant to decision making so much as the cultivation of a state of mind which helps orient potential users to the value of decision-relevant future information. This point of view corresponds to Marshall Mc Luhan's contention that " the medium is the message ". In that sense the mere presence of a new technology (futurism), which changes society's temporal attention from the present to the future, can have a more profound impact than will any of the particular forecasts made. However, this benefit of future estimates to the development and institutionalization of a normative planning capability is indirect at best and cannot be considered a sufficient design criterion for an EIS.

An Approach to EIS Design

Let us redefine the concept of an EIS to emphasize those characteristics which require more attention. An EIS is thus a means for making estimates of the future :

(1) which are relevant to the needs of a predetermined user, and
(2) in which the influencing effect of policy is explicitly represented.

Design Strategy

The basic design strategy which we have found useful involves an additional definitional question. It is obvious that most forecasting systems, whether explicit or intuitive, make use of historically derived models and data. We term such an historical model as being *predictive.* A predictive model is non-temporal and states only that the characteristics of outputs may be predicted from the characteristics of inputs.

In order to estimate the future, of course, it is also necessary to introduce temporally sensitive relationships into an EIS. We use the term *projection* to indicate the relationship between the past and future characteristics of an input. That is to say, the future characteristics of an input may be derived from its past characteristics through the use of projection models.

Finally, the term *forecast* is employed to designate the future characteristics of outputs (the environmental estimates). Forecasts are derived by applying the historically derived *predictive* relationships to the *projected* characteristics of the inputs.

This EIS design strategy is based on two assumptions. First, it assumes that historically valid predictive relationships will remain valid in the future. Second, it assumes that the inherent error in the predictive relationship plus the error introduced in the projection of inputs is less than the error involved in the direct projection of outputs.

Policy

In this design strategy policy variation is accomodated in the projection process. Inputs are examined to determine to what degree they appear to be controllable or policy sensitive. The policies currently governing controllable inputs are made explicit and the inputs are initially projected under the assumption of no policy change. The environmental outcomes which emerge from the use of these input projections in the predictive model are termed *policy constant forecasts.*

Policy constant forecasts may be characterized in the following way :

> Given the environmental situation the way it is today, and given the policies currently governing the situation, if no policy changes occur during the intervening time period, the future environmental situation (outcome) should be as forecast.

To the extent that a set of policy constant forecasts of the future environment is unfavorable and suggests a search for alternatives, or to the extent that an estimate of the sensitivity of environmental forecasts to changes in policy is desired, a series of iterations may be undertaken. Two choices are available : (1) either a substitute outcome (more hospitable future environment) may be designated and an alternative set of policies derived by determining the required future values of inputs to satisfy the new conditions, or (2) a set of alternative policies governing one or more of the inputs may be introduced into the EIS and the alternative future outcomes which they imply may be derived. This process may be repeated until a preferred set of policies becomes evident. These classes of future estimates are termed *policy contingent forecasts*. Policy contingent forecasts may be characterized in the following way :

> Given the environmental situation the way it is today, and given the policies currently governing the situation, if the following policy changes are introduced during the intervening time period, the future environmental situation should be as forecast.
>
> Policy change 1
> 2
> 3
> .
> .
> .
> n

In all of the forecasts, then, an attempt is made explicitly to state the underlying policy framework which is responsible for the outcome.

Feedback

Feedback from the future to the present is obtained in this design strategy partly through the recycling of policy alternatives described above. This aspect of feedback, of course, assumes that the system design, i.e., the predictive models and the projection models which constitute it, is error free.

Of perhaps greater importance is the ability to monitor feedback as the EIS operates over time. This kind of EIS is intended to be institutionalized and operated at prescribed intervals which bear a relationship to the length of the projection period. For example, an EIS for 10 to 15 year forecasts might be updated and operated only once or twice per year while an EIS for one year forecasts might be exercised monthly. While the time horizon of the system will move forward with each passing time interval (to maintain a constant forecast depth) it will be possible to monitor the current performance of inputs against projections made in prior time periods. This should provide rationale for policy and decision review functions over time, on the one hand, and possibly a gradual reduction in the error level inherent in the predictive and projection models of the EIS on the other.

Quantification

Quantification holds great appeal for the analysis of complex systems. Among its advantages are (1) the use of a common numerical language for the assessment of disparate concepts and for cross-actor comparisons, (2) the compression of input data which makes feasible the enlargement of the total data base available to the user, and (3) the ease of storage and manipulation of data so that more extensive examination of more outputs can be performed more rapidly and economically through utilization of computers.

However, quantification can manifest serious drawbacks when spuriously employed in EIS design. In particular, quantitative measurement of social and political processes frequently requires a level of empirical theoretical development and verification beyond that which currently exists. In addition, it requires a degree of specificity in operationalizing an EIS which cannot encompass the nuances typical of qualitative descriptions of social and political processes. Further, it tends to suggest a mechanistic view of the environment which, in certain circumstances, can be worse than no view at all in terms of its consequences for an unwary user.

After weighing these advantages and disadvantages, our posture of this issue still favors quantification to the extent possible. Users must be cautioned that a quantitatively based EIS results in environmental estimates which must be reviewed and augmented by experts. These experts can interpret the outcomes to the user and supply missing non-quantitative ingredients which influence the estimates. However, it is expected that over time both the quantitative content and the reliability of environmental information systems will increase through appropriate research (1).

(1) For a lucid discussion of opposing points of view concerning the value of quantitative methods in international relations, for example, see Hedley Bull, "*International Theory, The Case for a Classical Approach*", *World Politics*, April 1966, and R.N. Rosecrance and J.E. Mueller, "*Decision Making and the Quantitative Analysis of International Relations*", The Year Book of World Affairs, 1967, Volume 21.

Describing an approach to EIS design is a far cry from operationalizing such a system. Let us examine the process of design and some of the problems which must be overcome before implementation of an EIS is warranted.

Designing an EIS

The design of an EIS requires attention to a variety of subjects. It is convenient to group them in the order in which they will be discussed, as follows :

1. users, actors, and outputs ;
2. predictive models and data banks ;
3. projection models.

Users, Actors, and Outputs

Users of environmental information systems are themselves actors or actor surrogates within the environment they wish to monitor and forecast. Users who are associated with organizing functions in society will normally be concerned both with the alternative policies responsible for future environmental outcomes and the outcomes themselves. Their social charter, as noted earlier, is the influence and control of outcomes. Users who are associated with processing and connective functions in society will normally be concerned less with policy determination than with likely future outcomes to which they must accommodate or adapt. However, in pluralistic societies, alternative paths do exist through which the latter users also influence policy.

Considerable emphasis has been placed on the uniqueness of the environment relevant to any particular EIS user. As a rule this demands the involvement of the user in the determination of those environmental outcomes or system outputs which will best fill his informational needs. The system designer must subordinate his own view of what is or what should be important to the user.

A dialogue between user and designer is necessary to resolve the following kinds of questions:

1. What decisions are made which require environmental estimates ?
2. What is the source and type of environmental estimates currently employed, if any ?
3. What environmental actors are of primary concern ?
4. How frequently, or at what intervals, must environmental estimates be available ?
5. To what future time frame must the estimates be oriented ?

Getting answers to such questions is not a trivial task. Often an interview will reveal that the user simply cannot provide answers. It is helpful, therefore, to review the user's designated " charter " to review public policy positions taken by the user, and to review recent decisions made by the user in an attempt to distil the rationale employed and therefore his implicit environmental context. Whatever course this process takes it must culminate in a set of environmental outcomes to be embraced in the system design and identification of the actor set which is relevant to these outcomes.

Care must be exercised that the outcomes be stipulated in operational terms. For example, a user in an international business firm may be interested in what he terms the " political stability " of various nations so that he may employ this criterion to minimize the long term risk in foreign investment decisions. But political stability may be operationalized in many ways, regardless of whether an EIS is or is not highly quantitative. Stability might be measured as the durability of existing political regimes, as the number of politically motivated deaths, as the attitude of regimes and/or their political oppositions to foreign investment, as the institutional process of political succession, as some combination of these, or in some entirely different way. It is crucial that the user participate in the selection of an operationalization that is useful to him.

This step in EIS design is often the most important of all. The user, in order to participate, must rethink and make explicit the responsibilities and priorities of the social function he serves and his own role in that service.

Predictive Models and Data Banks

Armed with a set of relevant operational outputs, the EIS designer is in a position to locate or develop appropriate predictive models for use in the EIS. These models, as previously defined, are historically derived relationships between an output and a set of inputs.

The requirements for a predictive model are (1) that its output correspond to one of the predetermined relevant operational outputs, and (2) that it has been empirically verified to a known and acceptable level. With the exception of economics, such empirically based models are rarer today than we like to admit in the social and behavioral sciences. In political science, for example, the theoretical bases for such models are often remote from their operational design. Furthermore, empirically based causal models of political behavior are almost nonexistent. Instead, models based on covariance of inputs and outputs reflect the current state of art of theory building and testing. Nevertheless empiricism in political science is a relatively new and growing phenomenon. More and improved models may be expected to emerge from the field.

In the meantime, such predictive models as do exist may be sought in the research literature or at selected research centers. Failing that, directed research, either in-house or under contract with specialized research centers, is a relatively short term option available to develop predictive models for EIS application.

The data bank for any EIS is defined by the predictive models employed in the system. It consists only of data which measure past and current performance of the inputs required for prediction. Controlling the data requirements of the system in this way has the salutory effect of keeping the size of the data bank to a minimum. Data for other variables, no matter how high their implicit or intuitive interest, are excluded from the data bank unless and until the variable is shown to be a necessary input to a predictive model which produces an EIS output.

Normally, the data bank of an EIS will be computer stored. How the historical data are called forth, if at all, will depend on the projection models employed for each input.

Projection Models

The EIS concept contributes nothing new to the mechanics of projecting. Projection, in the sense of extrapolating the future value of an input from past values, may be accomplished only as well as existing extrapolation techniques permit. As we know, extrapolation techniques assume that the future will in some way resemble the past. The application of an extrapolation technique defines the particular way in which the future is anticipated to resemble the past.

While the EIS adds nothing new to the mechanics of projection it does contribute to the art of projecting. The contribution again lies in the realm of policy consideration. Rather than extrapolating all available historical data for an input, the behavior of these data are first scrutinized and the input assessed for its apparent controllability by policy. Because the initial output goal of an EIS is the policy constant forecast, only that part of the historical data which reflects current policy is initially projcted. In this way we attempt to be selective in terms of the characteristic of the future which we want to resemble the past.

Let us illustrate some of the foregoing design concepts with an example EIS.

Example EIS

Let us assume that the EIS user is a petroleum industry executive whose current investment decisions require forecasts of future patterns of demand for

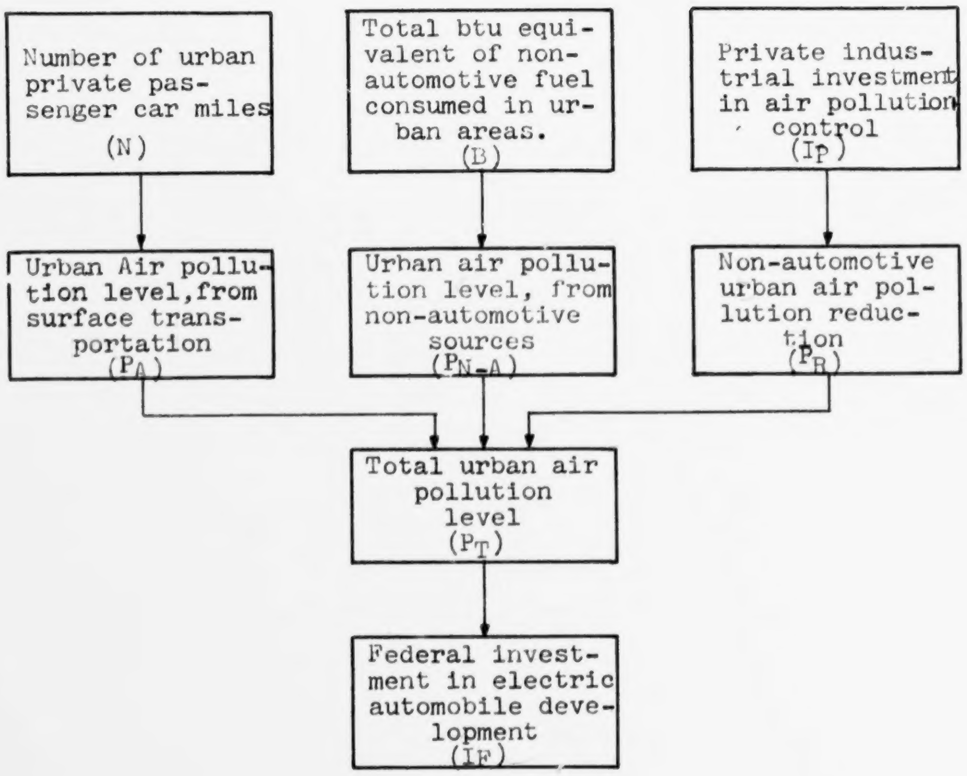
Number of urban private passenger car miles (N)
Total btu equivalent of non-automotive fuel consumed in urban areas. (B)
Private industrial investment in air pollution control (I_P)
Urban Air pollution level, from surface transportation (P_A)
Urban air pollution level, from non-automotive sources (P_{N-A})
Non-automotive urban air pollution reduction (P_R)
Total urban air pollution level (P_T)
Federal investment in electric automobile development (I_F)

Figure 2 - A Sample Predictive Model

petroleum products. Let us assume further that the attention of the EIS is to be focused on environmental outcomes which can importantly affect the demand for automotive fuel, in particular the future of the electric automobile. Specifically, it is determined that the actor of greatest interest to the user is the government, and the future outcome of importance is the level of governmental investment in the development of electric automotive technology.

A survey of the research literature reveals a little known predictive model whose output, federal government investment in electric automobile technology, closely corresponds to the desired EIS output. The model is depicted in Figure 2. The model, which we will also assume has been empirically verified, indicates that :

$I_F = f(P_T)$

where

I_F = federal investment in electric automobile development, and

P_T = total urban air pollution level.

In turn :

$P_T = P_A + P_{N\text{-}A} - P_R$

where

P_A = urban air pollution level from surface transportation,

$P_{N\text{-}A}$ = urban air pollution level from non-automotive sources, and

P_R = non-automotive urban air pollution reduction.

These three determinants of P_T are themselves functions of :

N = number of urban private passenger car miles,

B = total btu equivalent of non-automotive fuel consumed in urban areas, and

I_P = private industrial investment in air pollution control, respectively.

The input variables in this EIS are N, B, and I_P. Therefore, the data bank of the EIS consists of historical time series for these inputs. Let us assume that their historical data are as represented in Figure 3 for the historical period 1948 to 1968.

Because the forecasts of I_F will be obtained by applying future values of these inputs in the predictive model, we must extrapolate these historical data. But we shall not extrapolate until we attempt to assess the historical behavior of each input in terms of policy controllability, as the following examples illustrates :

1. For N, the combination of deferred World War II auto demand, the post-war economic expansion and the rapid growth of suburban communities

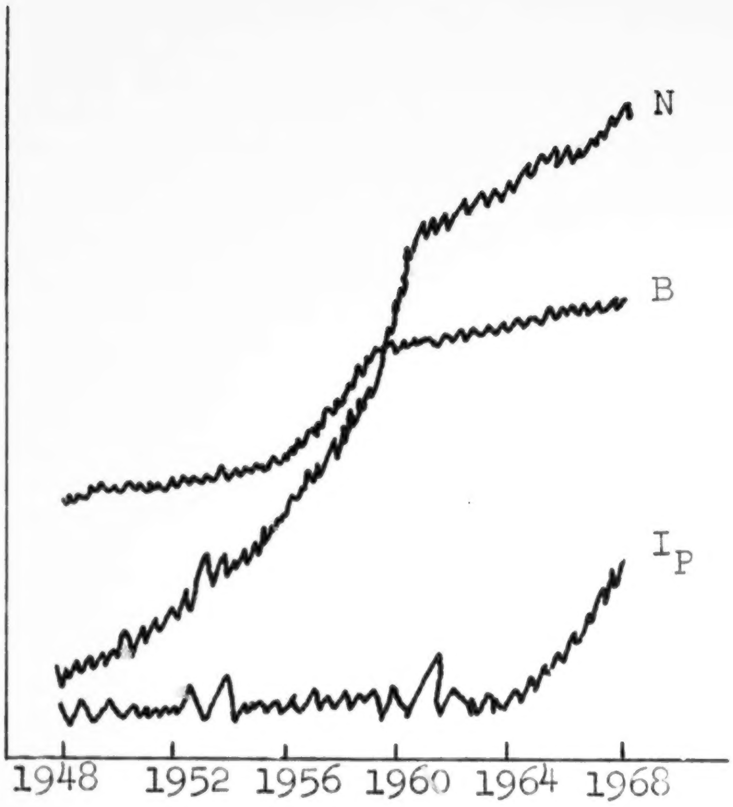

Figure 3 - A Sample Data Bank

combined to cause rapid increases in N from 1948 to 1960. Beyond 1960, a semi-saturation condition prevailed, tempering the increase in N. The period 1960-1968 then may be taken to represent the composite current policy of the private automobile using population with regard to urban utilization.

2. For I_P, a rapid increase is seen to occur between 1964 and 1968 in response to government subsidies for this purpose, coupled with public pressure on major smoke producing industries such as petroleum refining, electric power generation, and steel. This period, 1964 to 1968, then represents the response of the input variable to *current policy*.

Obviously, such policy assessments are subjective, gross, and may in fact be erroneous. But the fact that they are made explicit (1) provides a rationale for selecting an appropriate extrapolation technique (by defining that part of the data universe which is to be projected), (2) provides a rationale for selecting that characteristic of the past which the future will resemble, and (3) exposes " current policy " in such a way that in subsequent projections alternative policy assumptions may be explored for their effects on the shape of the future environment.

Let us return now to the user, the petroleum industry executive. Let us assume that the policy constant forecast of I_F shows it growing at a rapid rate. The user has two options. First, he can accept the forecast and make the necessary adjustments in his investment decisions (hopefully applying needed expert augmentation of the quantitative EIS forecast), and thereby *adapt* to this view of the future. Second, he can return to the EIS and explore various policy alternatives, both those over which he may have no control and those he can control or influence.

In the former case, for example, he may assume that local governments will begin to restrict the use of private automobiles in the central city and improve the quality and availability of urban mass transport systems. He must then estimate the effect of these changes on the future value of N and ultimately on I_F. Or, he may assume that more generous incentives or more onerous penalties will affect the behavior of I_P and thereby reduce the forecast level I_F. Now he must ask whether the alternative outcomes that these policy contingent forecasts provide will significantly change the investment decisions he must make. He is still in an adaptive posture.

In the latter case, however, he may try to determine within the EIS how effective a large privately sponsored increase in I_P would be toward inhibiting the forecast increase in I_F, and therefore in potentially reduced demand for automotive fuel. If the resulting policy contigent forecast suggests that this is an effective alternative then he may choose to promote this policy change within the industrial community and thereby attempt to influence or shape the future. Furthermore, if this alternative is properly brought to the attention of relevant government actors, the public resources which might otherwise be designated for support of electric automotive technology might be more effectively reallocated to improve incentives to further increase IP.

State of the Art

The foregoing discussion and example should already have conveyed to the reader an appreciation of the current rudimentary state of art of the design and development of environmental information systems. At this point in their " technology " it is clearly their potential utility and power rather than their current status which demands serious pursuit of the concept. For all their nuances, insights, and rhetorical detail, intuitive forecasts of the future environment have too frequently been misleading or inadequate. They tend to be non-replicable, non-continuous and non-systematic. They therefore may not be easily evaluated in retrospect to learn how to do better in the future. In a sense this represents the standard of performance against which the value of EIS development must be measured.

On the other hand, an EIS with proper user orientation offers a vehicle for bringing empirically based social and behavioral science research to bear on complex decision problems. However rudimentary the current state of such research, its focus on social decision making is certain to encourage increasingly rapid development. This current weakness in EIS state of art, then, will one day surely be a strength.

Finally, it must be emphasized that the approach to EIS design outlined herein does not introduce any new problems to the task of environmental forecasting, i.e., problems not already present in other more conventional means of producing such forecasts. This EIS design strategy simply requires that as much as possible of the policy rationale, data, and methods underlying the forecast be made explicit and be exposed to the user. The user then is afforded the opportunity to accept, reject, or otherwise evaluate all forecasts on the basis of their origin rather than on the basis of their content alone.

POLITICAL INFORMATION SYSTEMS

by

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When, 200 years from now, historians write about the Communications Revolution of the 20th Century the computer will figure as a central invention in their narrative. They are likely to talk but little about its effects on mathematics and natural science. They are likely to talk a great deal about its effects on the sciences of man and behavior. They may consider that the computer virtually created what they will then call modern social science, though they will, of course, recognize that the embryonic social sciences struggled to maturity over a 2500 year pregnancy. The most revolutionary effects of the computer are likely to seem to them to be those in social technology and in the sciences which are implemented in that social technology.

The details of this probable course of evolution are unforseeable. If that were not so we would have it in our power to make them happen now. For the long-term future, the best we can infer are certain broad overdetermined outcomes. We cannot guess which of many paths will lead there. It is more profitable, therefore, to look at the short run and see what the interaction is likely to be in the next few years between the computer, and the presently existing technology.

Let us consider first some of the distinctive characteristics of the social sciences that affect the way in which they use computers.

Then we shall examine some computer applications to the social sciences that have already been realized.

Third we shall turn to promising social science computer applications not yet realized.

Finally, in closing, we shall speculate about effects on society that may result from some of these social science applications of computer technology.

No sharp distinction separates the social from the natural sciences. Any easy distinction breaks down if one examines in detail what social scientists and natural scientists actually do. Some humanists assert that there can be no true social science because of the fact of free will. It is hard to see, however, why free will should make it unscientific to observe the play groups of children while it is scientific to observe play groups of porpoises. It is hard to see why free will makes mathematical expression of the relation between the velocity of a flow of money and price levels unscientific but not the flow of water and water levels.

Any of these phenomena can be interfered with by human beings intent on deliberately changing the situation. You can capture or train a porpoise. You can regulate or educate a child. You can dam a river. You can fix prices. The ability wilfully to change a situation by an exogenous interference is not different in the social or natural realms.

Yet, even if no absolute distinction separates all social from all natural sciences, still there are differences between them of great significance in emphasis and degree. Problems that are acute and central in one of these realms of science may be peripheral and minor in the other. We can legitimately characterize the social sciences, once we have recognized that any such characterization is only a quantitative statement that is true of many areas of the social sciences, but not of all, and more often true of the social than of the natural sciences.

We can, in short, make empirical social statements about the differences in the modal activities of natural and social scientists, even if we cannot make philosophical statements about the logical differences between them.

We may single out four characteristics of the social sciences that profoundly affect the way in which they use computers.

1. First, the social sciences generally describe multivariate systems. Neither in the physical nor the social sciences are beautifully simple relations typical, such as those of the laws of gases in which the interaction of but two variables, temperature and pressures, give us highly precise prediction. Some aspects of economics, such as the quantitative theory of money and the micro-economics of prices, are like that. So are some aspects of psychology such as models of the memorization of nonsense syllables and some models of simple perception. Yet generally speaking, social science phenomena are extremely complex. What determines how a person votes ? It is his class, his education, his age, sex, religion, region of origin, urban or rural residence. It is the personal influence of his family, friends, neighbors, and co-workers. A woman tends to vote as her husband. Also ideology enters in. A principle of inertia keeps people voting for policies that were vital to them in their more formative youthful years making them seem conservative relative to their times as they grow older. The great depression, Stalin, Hitler, the wars all left their continuing mark on their generation of voters in ways that today's youth find hard to understand. Furthermore a psychological craving for consistency affects the way people vote. A person who thinks he is a Marxist, for example, wishes to be both for the labor movement and for internationalism, and finds himself in difficulty in those common situations when organized labor turns out to be chauvinistic and xenophobic. Furthermore a person's vote is determined by structural facts that affect strategy. Is the candidate who has a plurality elected – so a well organized and large minority has a chance – or does the law require him to get

an absolute majority. If the latter, is a second turn run-off provided or how are deadlocks broken. All of this affects whether to vote first for one's first choice or to settle for a second best compromise candidate who has a good chance of winning. All of these demographic, social, ideological, and structural facts effect how people vote.

The multivariate character of social situations could be illustrated by many other examples. What determines whether a city grows : its geography and situation on lines of communication, the growth or non-growth of the neighboring urban centers, the state of the economy and all the myriad things which affect that, the net reproduction rate and all the biological and social facts which affect that, tax policies, building policies and technology, war and peace, refugee movements and migrations, the quality of government, and people's values and attitudes towards urban life.

The fact that most interesting social science problems are multivariate has been often observed but seldom well explained. The usual explanation is a fallacious one. It is what is called " reductionism. " Physics, it is argued, deals with simple particles of matter in motion and energy. Chemistry looks at more complex aspects of matter, which, however, if we understood how, reduce to physics. Biology, because it deals with living matter is a more complex form of chemistry. Social science in turn is thought of as a structure superimposed upon biology. The trouble with this explanation is that there is no inherent reason why higher order systems require more complex explanatory theories than the lower order ones.

Let us consider, for example, the theory necessary to explain the behavior of a man playing tic tac toe. There is no reason, whatsoever, to bring psychology, and biology, and chemistry, and physics into our theory ; even though psychological and chemical and physical processes are going on. A very simple theory is possible, predicated on both players wishing to win, accepting the rules of the game, and being mathematically skilled. Wanting to win is a very complex psychological phenomenon, but to theorize about tic tac toe one need only postulate it, not theorize about it.

So the reductionist theory does not explain the multivariate character of most of the social sciences. There is another explanation that has not been generally noted : the object of most social science propositions is intelligent beings who in pursuit of their own goals manipulate and modify any relationship that is obvious to them.

Consider, for example, the matter of voting behavior. Some oversimple, but partly accurate theories of voting behavior assert that men act at the polls on behalf of their class interest. Let us suppose that this were true to any very large degree. If it were so then electoral procedures would be adopted to obstruct class dominance or class rebellion as the case might be. Candidates would all mimic the most popular class affiliation, and voters would be left with only secondary criteria on the basis of which to choose. The proposition that class was the dominant variable in determining votes would prove to be a self-defeating prediction.

Much attention has been given by philosophers of social science to self-fulfilling and self-defeating predictions. It has been argued by some that the existence of these phenomena make a true social science impossible. It has been argued that since the objects of social science predictions are intelligent beings, they will hear and understand the predictions of researchers and act in such ways as will falsify them. For example, it can be argued that it is literally impossible to predict the behavior of the stock market. If anyone were able to say with certainty that it would rise the day after tomorrow, then investors would follow the prophet and rush in to invest to-day causing the market to rise immediately, not the day after. All theories of stock market behavior are theories about human behavior in an uncertain environment. Certainty destroys the reality which the theories explain.

There are several fallacies to the argument that social science predictions about intelligent beings who hear the predictions is impossible (1). For one thing, social science findings may become known to those they describe without causing them to change. Telling a candidate who wins votes by his sunny cheerful disposition that he acts that way because of infantile experiences in relation to his parents, may produce a willing assent or a grunt of incredulity, but not necessarily any change in his successful campaign style.

Furthermore, not all findings become known to those they describe. Some seem too irrelevant to be of interest : for example, few candidates for election take the trouble to inform themselves about social science studies of how attitude change takes place in campaigns. Furthermore, some studies are kept secret. An additional point properly made is that the self-fulfilling and self-defeating prophecy are merely special cases of a general scientific problem that observation may change the phenomenon observed. One cannot insert a thermometer in a body without changing its temperature. One cannot collect samples of the atmosphere of Venus without changing it. If observations that falsify themselves make science impossible, then all science is impossible.

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(1) Good discussions of this issue may be found in : Kaplan, Abraham, *The Conduct of Inquiry : Methodology for Behavioral Science,* San Francisco, Chandler Publishing Co., 1964 ; and in : Nagel, Ernest, *Structure of Science : Problems in the Logic of Scientific Explanation,* New York, Harcourt, Brace and World, 1961.

Finally, far from being falsified by being known, some social science predictions depend for their validity on people knowing them and acting accordingly. Game theory and classical economics are both examples of models whose predictions depend upon the actors having complete information and acting on it. These models of rational behavior analyze what a man should do to achieve his goals under specific circumstances of conflict and competition. A model that shows what behavior will maximize a man's income, for example, is likely to become more descriptive of how a man acts if the man is exposed to knowledge of the model and thus learns how to maximize his income. The model is likely to be empirically inaccurate if the actor is *not* informed about his optimum strategy.

Clearly it is an error to generalize that prediction of human behavior is possible only if the object of the prediction is uninformed about the prediction. That is often the case, particularly where the prediction reveals that a man is heading toward an undesired fate ; such predictions may defeat themselves. But not all predictions have that character.

Nonetheless, social science predictions of a self-defeating nature are sufficienthy frequent for them to affect the overall character of the social sciences, even if they do not destroy their logical status as science. Enough predictions are effective warnings about undesired fates that people manage to avoid making much of social science into a polemical tool for advocates of reform rather than a collection of successful predictions. Analyses of the dangers of war, or of revolution, or of urban decay, or of family disorganization, or of economic instability more often than not describe conditions that are partially evaded by purposeful men once they become aware of the situation they face.

Thus there is a large class of unlikely outcomes, namely ones where a clear-cut, widely recognized, reasonably confident social science analysis exists that demonstrates a more or less undesirable outcome of a course of action. The existence of that class of outcomes explains why so much of social science deals with multivariate systems. Where one or two variables dominate a situation intelligent policy makers and activists are likely to foresee their consequences and see what to do about them. The dominant variables are then stalemated. The many other less obvious determinants then come into their own.

Clearly society is not very good at running itself well. Social evils and catastrophes are rampant. But the ones that occur are most likely to be the outcome of subtle interactions among a large number of complex variables, so large and subtle that intelligent men walk into their fates unknowingly. Urban blight is a good example. Tax laws, immigration laws, business considerations, traffic choices, and technology all interact to turn neighborhoods from homesites into slums. These changes seem to work inexorably despite counteracting efforts of men of power and good will. If there were a single dominant variable one could be quite sure that at least some mayors and city councils would have placed it under control long since. Indeed they have done that with several potential dominant variables. They have created fire departments that prevent our cities from burning down. They have created traffic and utility systems that make it possible for millions of people to congregate in a small area. What remains unmanaged is the interaction of a series of less obvious variables, about which no one can be glibly confident as to the right course of action. It is their interaction that brings the downfall of large urban areas. Only careful multivariate analysis can help gain more control over those residual fluctuations of the system.

We have now established one key characteristic of the social sciences and the reason for it. The social sciences usually describe multivariate systems in which there are no one or two dominant variables to account for most of the variance, but rather a large number of weak variables in complex systems of interaction, and they do so because men control obvious dominant variables.

2. A second characteristic of the social sciences follows almost as a *corollary*. The social sciences are data rich and theory poor. The systems they analyse usually have to be described with large numbers of parameter measurements. On the other hand, theories are hard to come by that explain more than a few variables. Carl Hovland has pointed out, there are rather good theories that predict attitude change in a laboratory situation, but they seldom appear to have relevance to real life attitude studies in the field. The reason is that in the laboratory subjects are paid to listen to a message to which they respond. In real-life uncontrolled situations, people choose what they will pay attention to, and they avoid paying attention to anything that will change their minds. Thus our knowledge of real life attitude change consists largely of poll statistics about what was believed by people at different times and places. We have little theory that could predict and thus eliminate the need for large-scale empirical compilation.

3. A third characteristic of the social sciences which also follows, is that they are generally phenomenological, describing natural environments rather than working with well-controlled experimentation. There is some experimentation done in the social sciences, but as we noted in the example just above, what it gains in rigor it loses in immediate relevance. The value of rigorous laboratory

work is inestimably great. Nonetheless, quantitatively most of what students of society wish to know is specific to some contentual situation. It is a problem in some region, at some specific period of time for some particular group of people. Thus most of social science is phenomenological.

4. A fourth characteristic of the social sciences is that they are historical. Human beings, like animals, but unlike most objects of the natural sciences, have memories. What they do is not only dependent upon the present condition but also on everything they know from the past. A pendulum of a certain length pulled back a certain distance will swing the same way whether the experiment is done the first or the 50th time. A person given an identical task to do in identical circumstances may do a very different thing the second or nth time, for his circumstances are really different each time, since he retains in memory the experience of the previous times. Thus Markov chain models are often wrong for description of human behavior. They take no account of experience before the present state of the system. In most social science models at least some variables must be time dependent.

These four characteristics of the social sciences all make them particularly susceptible to help from computerization. Computers are instruments that efficiently store, search, organize and reorganize large sets of data or other symbols. Up to now, however, the predominant use of computers by social scientists has not taken account of the distinctive characteristics of either the social sciences or of the computer itself. Up to now computers have been used by social scientists mostly as large arithmetic calculators. Statistics is a discipline with a long and reputable history in the social sciences. The problems to which Galton, Pearson, Fisher and others addressed themselves were generally social. Censures and economic measures have kept most statisticians busy. The sophistication of social statistics is at least as great as that of statistics in any other field. To social scientists with much statistical calculation to do the arrival of the computer was indeed a blessing. It saved numerous hours of research assistant time.

That, however, is a use of the computer which illustrates the familiar pheonomenon of the persistance of old habits in the use of a new technology. Early automobiles were built to look like horse carriages. Computers were originally designed by mathematicians and engineers who conceived of them as machines to compute. This is attested to by the misleading name " computer " which still clings to these devices for manipulating symbols.

The name has its effect. Even to-day most computation centers run with hardware-software configurations designed to optimize the ability to compute.

Batch processing centers tend to evaluate their systems by how fast they perform the basic arithmetic operations. Most time-sharing systems provide the user at his console with what is in effect a desk calculator. Only a few sophisticated systems such as CTSS (1) provide him with any facility for organizing and manipulating files.

One reason for the preoccupation of computer centers with computing and their inadequate preoccupation with other forms of symbol manipulation is the fact that only people with considerable training in mathematics and physics can understand and work at developing the computer systems themselves. Persons whose skill and knowledge lie in the area of non-mathematical symbol management — historians for example — are not competent to work at developing computer configurations which meet their needs. So the engineers and programmers build systems that serve the needs of engineers and programmers themselves. It will take time before the system builders come to understand what is wanted and needed by such people as personnel managers, librarians, city planners, public opinion pollers, criminologists, historians, or others of the myriad potential users who organize and re-organize files of records, but who do relatively little advanced computation.

For all these reasons the computer revolution in the social sciences may come a little more slowly than one might otherwise expect given the natural affinity of the computer's capabilities and the social sciences' needs. Whether slowly or fast, however, we can delineate some of the kinds of things that will increasingly be done with computers by social scientists and that will transform those disciplines. We can predict the increasing use of simulation models to represent multivariate systems too complex to allow of analytic solutions. We can predict the development of large data systems with automated retrieval and on-line analysis. The data files will come from many sources, much of it as a by product of normal management record keeping. At the same time, we predict, social indicators will be developed to measure such matters as discontent, health, and educational progress, to supplement such familiar economic indicators as GNP and unemployment rates.

Computer simulation models have been used in the social sciences in a number of applications. Social scientists have simulated the functioning of a business firm, an industry, and also the economy of a whole country. They have simulated bargaining between nations and the process of decision-making in a crisis. They have simulated the growth of population from generation to generation. They have simulated the spread of a fad and the spread of an innovation in a population. They have simulated the communication system of a country. They have simulated the electorate and how it makes up its mind.

(1) CTSS — Compatible Time Sharing System, an IBM 7094 based time sharing system developed at the Massachusetts Institute of Technology.

Simulations are useful when there are many and discontinuous variables in operation. Let us consider two examples. We shall take as our examples the simulation of decision making in a crisis and the simulation of the diffusion of information through the mass media system of a country.

One issue that has been much discussed is the extent to which conflict between nations can be accounted for by psychological factors in the behavior of national leaders, and the extent to which such conflict can be controlled by reducing their irrational responses. It is not obvious that wars are mistakes by emotionally involved men or that they could be avoided if pride, short-sightedness and misperception were less prevalent. But it may be at least partially true. There is no easy way to come up with valid evidence as to causal factors in the multivariate complexity of a crisis.

One indirect way to explore this subject is to construct a simulation of international crises in which the model is derived entirely from what we know about the psychology of inter-personal behavior and then to see how well it replicates what actually happens in international crises. Let us list a few of the propositions about how individuals behave in decision making :

> The number of different messages of alternatives that a person can weigh at once is about 7 ± 2.
>
> The number of messages that a person weighs rises and then declines with his level of tensions. It is an inverted V shaped function, but for extreme crises the important part of the curve is that the number of alternatives he considers declines.
>
> A decision maker pays more attention to messages concerning himself.
>
> A decision maker pays more attention to messages concurring with his previous beliefs than to those contradicting them.

Now, the first two of those propositions lend themselves to a mathematical model which might then be tested experimentally. One could express a model of attention and tension in a series of equations. However, if one wishes to include the other propositions, and particularly the fourth in a system, one clearly needs a stochastic model that allows one to make a qualitative comparison of meaning of the new message against each previously held belief of the decision maker. The order of the messages makes a difference for it determines what is already stored as previous beliefs.

A computer simulation can represent such a discontinuous stochastic process. I have simulated such a process by computer model (1). A number of users of Harold Guetzkow's Internation Simulation, e.g. Paul Smoker, have attempted to develop computer representations of its processes. The early results are least provocative. The parallels between behavior predicted on purely psychological grounds and historical behavior are close enough to justify an intensive study of this problem.

Another simulation model on which I have been working is aimed at improving estimates of the extent of exposure to propaganda and persuasion to mass madia. We noted above that we know a good deal about what happens in a laboratory when a subject is exposed to an argument, but that in the real world all sorts of circumstances affect whether the person ever gets exposed at all.

For advanced countries it is possible to find a great deal of data about the size of mass media audiences. Every newspaper and magazine has data about its circulation and the composition of its audience. Radio and television have rating data. Time budget data tells us how people use their leisure. It is also possible to tabulate the messages and themes carried in this material and their frequency. But to translate all that into a set of frequencies with which persons of different types get exposed to various messages is very difficult indeed. Three of the mechanisms which must be considered are called cumulation, duplication, and triggering.

Cumulation may be illustrated by comparing two magazines both of which reach 15% of the adult population. One, circulating by subscription only, may reach the same 15% with every issue. The other, sold at newsstands on an impulse basis, may have few repeat buyers and may reach half the population in half a dozen issues. They differ greatly in their efficacy in spreading messages, even though they have the same circulation.

Duplication is essentially a similar concept, but between media. Do people who follow news on radio read more or less newspaper news than those who skip the radio ? Paul Lazersfeld demonstrated that they read more. (*Radio and the Printed Page* 1940). In other words a taste for news proved to be a more powerful variable here than saturation.

(1) Pool, Ithiel de Sola, and Kessler, Allan, " Crisiscom : A Computer Simulation of Perception and Decision Making During a Crisis, " *IEEE International Convention Record,* Part 6, 1965 ;
" The Kaiser, The Tsar, and the Computer : Information Processing in a Crisis " *The American Behavioral Scientist,* Vol VIII, No. 9 May, 1965 ; and,
" Crisiscom : A Computer Simulation of Human Information Processing During a Crisis ", *IEEE Transactions on Systems Science and Cybernetics,* Vol. SSC-I, No. 1, November, 1965.

By triggering we mean the sequence dependence between messages. After a person first hears about a crisis, for example, that Dr. Martin Luther King was assassinated, he turns to the media and absorbs more news messages than he normally would.

When a person hears a message once maybe he does not really believe it. In many situations it takes a repetition from a second source before the message is treated as real. In such situations we wish to know not how many persons have heard a message, but how many have heard it at least twice.

Triggering mechanisms are order dependent, discontinuous and stochastic, so a simulation model is necessary to represent the process ; an analytic solution to the estimation of message flow through the mass media is not possible.

Implicit in what I have been saying is the belief that it is possible to represent in a computer model virtually any set of precisely expressed relations. Scientific theories are after all sets of symbols, whether in linguistic or graphical or mathematical form. Any of these can be expressed in computer interpretable code. If the original expression was unambiguous then a computer interpretable translation is possible. For the social sciences the computer interpretable formulation of the theory is particularly valuable because social theories are so complex and multivariate that the human mind is pushed beyond its limited capacity to keep things straight and to analyze them. The human mind is skilful at simplification. Intuition serves us well in homing in on key variables and relationships. However, the human analyst cannot begin to compare with the computer in accurate and detailed calculation of the interactions in a complex system.

If we are right in characterizing not only present but future social theories as predominantly multivariate simulations, lacking strongly dominant variables, then several important things follow. Predictions from such theories are highly dependent upon numerous empirical measurements. From the point of view of a person who controls any one variable, only a little can be predicted without entering large numbers of parametric measures on the other variables into his calculations. It is in the nature of things that the social sciences are data rich and theory poor. It is not just that we are at a primitive stage in them.

Measures of social phenomena are therefore central to the development of social science. The census, social statistics of all kinds are the basis of any social science. If we look at the history of economics, for example, we find that theory developed best on those topics on which statistics were readily available. The most precocious part of economics was the theory of foreign trade. It developed long before the theory of the domestic market because at national frontiers the custom men collected data on everything that crossed. Similarly, the theory of banking grew early because banks generated records.

Today economics is the most advanced of the social sciences, very largely because business accounting makes it feasible to compile good economic indicators. We have available measures of cost of living, wholesale prices, GNP, bank transactions, stock averages, savings, investments, production levels, employment, unemployment, costs of production and volume of trade.

Now the interest of the social sciences is increasingly turning to the measurement of satisfaction and of those behaviors in society that cannot be kept track of by money accounts. Today there is an increasing awareness of the need for social indicators that measure such matters as discontent, health, political attitudes, and educational progress. If society is to evaluate its performance in such fields as race relations, education, or citizen contentment, we need social indicators based upon measurement of non-economic aspects of human behavior, and even on people's attitudes.

The identification of useful social indicators is a task calling for considerable theoretical sophistication. We usually measure societies' progress in education by the increase in the average years of schooling. We have no idea, however, whether a man now completing the 12th grade is better or worse educated than he would have been 30 years ago. In the United States, as a result of the revolution in race relations in the past few years, Negroes are filling better jobs than they used to, but their levels of aspiration are also properly rising. No one can say whether the degree of contentment or bitterness in the Negro ghettos is greater or less than it was two years ago. These are the kinds of phenomena for which standardized reliable measurements are necessary.

It will, of course, be objected that monetary measurements are easy, but that measurements of attitude, beliefs, knowledge or contentement are somehow subjective and unfeasible. Clearly, they are difficult to make , that is why they have come more slowly. Yet even today we have available a few examples of well-accepted and reliable social indicators to provide an existence proof for their possibility. The I.Q. is an example of a widely accepted, reasonably reliable, and standardized measure of a subtle psychological fact. It is as stable and well accepted as many of the conventional economic measures. Another example is a social indicator that almost inadvertently has come to play a major role in American political life ; namely, the Gallup Poll's repeated question asking whether the citizens believe the President of the United States is doing a good job. This question is asked periodically of a national sample. The results are prominently reported in the press and awaited by the politicians. The movement of this indicator has become as politically important as many of the constitutionally authorized ballots, and certainly as important as many economic indicators. Major changes of national policy result from a loss of confidence in the President shown in this poll. His ability to influence Congress is seriously affected. One can no longer describe the American political system without reference to this political indicator.

All of this has nothing directly to do with computers. Computers are, of course, used to tabulate the results of a social survey, but what they contribute to that is a few days greater speed in analysis. The computer as a tabulating machine does nothing that unit record equipment did not do before, or that even hand tabulation could not practicably do. The significance of the computer is not in our ability to compile any one social indicator, but in our ability to compile and manipulate very large masses of data including large numbers of social indicators. For example, measurements of educational accomplishment need to be applied not only nationally, but school system by school system, (school by school, and teacher by teacher.)

Measurements of public health need to be controlled by all the varieties of treatments intentional and unintentional, which may affect the rates. The difficulties and the subtlety of analysis required to establish the conditions of diseases and health have been illustrated recently by the years it took to become aware of the medical consequences of smoking, and the difficulty in establishing these conclusions firmly.

The computer makes possible complex data management systems that will store, retrieve, organize and purge enormous bodies of information drawn from a multitude of sources in a variety of formats. We might describe such a computer-based information system as an information utility, using the term in the same sense as is now common for a computer utility. An information utility is a system that would permit many users to store, retrieve and analyze information of whatever sort might interest them in whatever format they chose, via a shared hardware and software facility that did not attempt to impose information objectives of its own upon the users. A great reference library is an example of a *non-computerized* information utility. It attempts to serve all users regardless of their special or professional interests. A *computer based* information utility could in principe provide the user with the same kind of service as a reference library and, in addition, with many advantages in speed, completeness of search and analytic power.

Despite its promise and potential social significance, no such computer-based comprehensive information system now exists. There are, of course, many special-purpose computer-based information systems. They differ fundamentally from the conception of a computer utility, or even of a private but comprehensive computer-based information system.

First of all, most computer-based information systems that now exist are essentially single file systems while we are talking here about a system that will handle many files at once. For example, a city planning information system will bring together, for analysis, files from different agencies on such matters as land parcels, firms and employment, demography, health care, welfare cases, school activities and performance, personnel, taxes, traffic, crimes, fires, expenditures, and many other things. In an integrated information system for a school or university, there would be student grade files and other student files, files on teachers, files on expenses, the library catalogue and circulation records, furniture and building maintenance files, etc. These different files are normally incompatible in their basic unit or item. Some are files of individuals, others are files of buildings, others are files of accounts. These disparate items can be referenced to each other when, for example, a student uses a building and pays money into an account, but they cannot be reduced to any one common structure for all purposes without great loss in efficiency.

There exist many good systems for handling single files. Items of information can be retrieved from them quickly and economically. Almost all such systems, however, try to cope with multiple files by turning them into single files for searching and analysis. Two or more files are given a common structure and then sorted and merged. That, however, is not a solution that will work for an entire data library or information utility. Suppose, for example, the records of a school system provided data on student performance by student, membership in classes, by teacher and seat arrangement in the classroom by classroom, and one wished to answer the question whether students of low potential do better in informal seminar type class arrangements. To answer that question would require a complicated cross-referencing among student, teacher and classroom files. Almost no present information system allows this sort of inquiry to be answered easily, on line, without special human operations to rearrange the data (1).

(1) This and each of the subsequent requirements for a computer-based information system are design criteria for a system being developed at M.I.T. by Stuart McIntosh, David Griffel and the author, known as the ADMINS system. The ADMINS system in a primitive version is now in daily use for social science data analysis. A version that meets the requirements of an information utility is under development. In the jargon of the ADMINS system, the kind of problem just alluded to in the text, that requires search of many files based on different kinds of items, is called multi-source and multi-level analysis.

Thus, the first requirement for a comprehensive computer-based information sytem is that it handle and cross reference many files simultaneously. For a computer utility by many files we mean thousands of files.

There are also a number of other design requirements that we can specify for a comprehensive computer-based information system. A second requirement is that it be a conversational interactive time-sharing system to handle many users. For an information utility it may have to handle hundreds of users. Each user must be able to explore the data in the system, not by means of receiving wastebaskets full of printout sometime the next day, but by the natural intellectual process of the game of twenty questions. He must be able to browse through the data by looking up a fact, then deciding what to look for next, and in that way efficiently closing in on the information he desires without exploring all cells of a vast multidimensional matrix of information.

Third, the user must be able to talk to a computer-based information system in the conventional term of his dicipline. He will seldom be a programmer. Whatever gibberish is used within the computer, the naming system of the user language and the operations in it must be stated in the familiar terms of the users science.

Fourth, we are talking about a system that the user sees as format-free. It must be able to accept data in whatever kind of code it may be kept, whether alpha-numeric, column-binary unconventional bit patterns, graphic representation, or any other form. I have not excluded natural language as tags. I do exclude for present consideration the problem of interpretation of natural language. The accomplishment of that goal is another task, an order of magnitude more difficult.

Fifth, we are talking about a system that the user sees as private to the extent that he wishes. While there may be large common files and exchange of information in a computer-based information system, the user must also have the right to operate in his private idiosyncratic naming system and to store his private files inaccessibly to anyone else. Though he sets up public files in his own idiosyncratic way, he should not actually waste spaces by duplicating them.

The issue of privacy is perhaps the most emotionally charged question in the entire discussion of computer-based information systems. There is no doubt that the issue is an important one. A computer-based system makes retrieval so much easier than it was in the past that the citizen has lost one of his protections from authoritarian oppressors ; namely, their gross inefficiency. This fact makes it all the more important that computer-based information systems be well designed to provide legal protection to those on whom data is collected. At the same time it should be stressed that, except for its greater efficiency, a computer-based information system provides the citizen with more protection than does a manual system. We all know that whatever a law may say, in practice unauthorized individuals often succeed in getting their hands on sensitive facts in manual files. This may happen in a computer-based system, too, although there are many additional protections not available in manual files. One of these is the mere technical complexity of the computer-based system. One needs to know a great deal to know how to misuse it. A second protection is that a computer system can be designed to keep a record of all transactions by which persons have searched the files. One protection against illicit searches is that the search will leave a trace. The problem of privacy is a large one that could be discussed at great length. In the end, however, it is not a matter of balancing technical advantages of manual vs. machine systems. In the end it is a matter of the laws and the law enforcement procedures and customs of a society. The technical balance is not onesided in favor of either a computer-based or manual system. The degree of privacy offered will, therefore, depend on other matters than the use or non-use of computers.

Sixth, we are talking about a *system of systems* in which different computers controlling different archives can talk to each other. For several years now there has been a great but irrelevant debate in the United States about a proposed national data center. The objective of a national data center was to take advantages of the vast files now available in government records to make social policy more effective. For example, employment is currently measured by recurrent samples surveys. At the same time, there exists in the social security system the potential for a far superior longitudinal measure of employment. We would like to know not only what proportion of the population is unemployed at a given moment, but what proportion of the unemployed has been unemployed, and how long, in the past few years. Only a longitudinal measure can tell us that accurately. Furthermore, if one could tie together the information on the unemployed, with the information that the same individuals provide to the census, to the army during their military service, and to their school systems, one could learn a great deal about those social pathologies that make for career difficulties. The advantages of a unified data system are obvious, so are the disadvantages. The proposal of a national data center immediately aroused a fear of invasion of privacy and excessive social control. The fear is not misplaced, but its target is. The fact of the matter is that in the future no advantage will be gained by moving data under one roof. Every computer is as close to every other computer as the nearest telephone line. It takes only ingenuity and permission to bring together data in files that are geographically remote. An information utility will not become involved in unnecessary battles to capture physical control of other people's information. The sensitive question will be the granting of permissions for intercomputer conversations.

Seventh, a computer-based information system must be able readily to update and purge rapidly changing data. That is now done well by many fixed format single-file systems such as airline reservation systems. For a comprehensive library to do this well, track must be kept of the many places where any particular fact might have ended up in storage and potentially in storage in any number of files. Also any user may have used it to create derivative files, which may also need to be kept up to date as the base data changes.

Eighth, a computer-based information system must make error correction easy. In our experiments with the design of such a system, we have found that in certain areas of social science analysis, such as survey analysis, more time is spent on correction of errors than on any other operation. One might add that many of the supposed corrections of errors are, in fact, introductions of new errors. The raw data must, therefore, be preserved against incorrect error correction.

Ninth, we are talking about a system with dynamic memory, of whose various levels the user is not aware. Information moves among core, drum, disc, tape and any other media according to algorithms based on use of the data, without the user knowing it or having to think of whether his memory complement is full.

Tenth, and one of the most important points of all, a computer-based information system must computerize both the archive management functions and the users' analysis activities. Most present computer-based information systems enable the user to do things much more efficiently that up to now he did with desk calculators, research assistants and unit record equipment. However, selecting out the user's body of data for analysis, putting it on the machine, removing it from the machine afterwards, storing it on a shelf somewhere, keeping track of when and how much it was used, and who else might want it, are all manual operations, with the clerical records kept on hard copy. A large information utility with thousands of files and hundreds of users presents a file management problem in its own management that is far larger and more in need of computerization than the analysis done by any one of the users. Conceptually, both sets of operations are file management and the same system should work for both.

Eleventh, a computer-based information system will keep a record of all operations performed on it so that they are retrievable and repeatable, and the user does not have to remember what he did.

One reason for maintaining this record is to provide the user with easy note-keeping of his analysis, but an equally important reason is that it is far cheaper to recompute much derivative data than to store it. Storing the operations performed on the raw data is usually a better procedure than storing the derived statistics.

Twelfth, the system should be recursive in that its output, which is also data, should be acceptable as input. The difference between raw data and the result is only a difference in viewpoint. For one analysis GNP is data, in another it is the result of a long process of calculation.

Thirteenth, to make a computer-based information system of the kind we have been describing economically possible, the data structures inside the computer must be efficient. Retrieving items of data and operating on them among thousands of files with hundreds of users is conceivable in the next decade or not, depending upon the efficiency with which data is found upon the disc, moved back and forth from disc to core, and operated on in both places. Specifically, it seems clear that information records must not be black boxes catalogued elsewhere, but rather self-contained, self-identifying records that can be operated on directly. The overhead cost of keeping track of black boxes or of operating through a host system designed for other purposes would probably make an information utility economically impossible.

The hardware and software configurations now found in virtually all computation centers are not designed to do the kinds of things we have been describing . Computation centers are generally run by mathematicians or engineers who think of computers as computing and programming machines, rather than as information processing machines. The configurations they develop are generally optimized for speed of computation. They are seldom optimized for such other considerations as economy of bulk data storage or ease of use for nonprogrammers, and certainly not for rapid identification of the content of the black boxes in storage. Specifically, almost no systems provide primitives which allow maximum efficiency in the manipulation of substantive information. That is one reason why computer-based information systems have often proved uneconomical up to now.

While none as yet exist, computer-based information utilities are now possible. In the broad, we know how to build them. We can also anticipate the revolutionary effect they will have upon our ability to plan society rationally.

At the same time, I should in closing be careful not to leave a wrong impression. The easy conclusion to which men jump when they become aware of the information capabilities that computers put before us, is that the computer will be a centralizing instrument. The assumption is that the planner sitting in the Capitol can see spread before him on his console all the details of the operation of the economy or society of his nation and can make rational decisions to make it function better. Clearly, this is an illusion, for it assumes the magnificent wisdom of this planner. But that is an issue which lies outside the scope of our present article. The relevant point to make here is not only that the onrush of centralization is a social illusion, but that it is also unnecessary. The information facilities provided by the computer can equally serve as a decentralizing instrument. They can make available to all parts of an organization the kinds of immediate and complete information that is today available only at the center. The power of top leadership today is very largely the power of an information monopoly. Only they are served by the armies of clerks that compile the records of what is going on. A society with computerized information facilities can make its choice between centralization and decentralization, because it will have the mechanical capability of moving information either way.

OPEN-ENDED PLANNING

by

Dennis GABOR (1)

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Introduction

My subject is planning of the sort which does not unduly restrict the freedom of future planners. It is an all-too-common observation that the well-intentioned plans of governments, which have miscarried by the emergence of unforeseen or unforeseeable difficulties, might tie the next government into knots – or even the same government if it stays long enough in office.

As we cannot expect prophetic powers from human beings, the question arises how governments can *play safe*,how they can leave a safety margin for the unforeseeable.

When a private individual wants to play safe, and wishes to provide for his own future and old age, he will abstain to some extent from consumption, and he will probably invest his savings in Unit Trusts. Not so long ago he may have invested in gilt-edged Government Bonds, or he would have taken out an insurance, but in an age of permanent inflation he will be better advised to buy Unit Trusts instead. He hereby distributes his personal risk over the whole or a good part of industry, in the reasonable hope that whatever may happen to individual companies, the grand average will not collapse.

A large company cannot get rid so easily of its responsibility for its future, it cannot shift it so easily on to others. It must decide whether its own line of industry will still be capable of expansion in ten or more years and, if the outlook is uncertain, it must look for other fields, not only for its capital, but also for its talents. (William Baumol's and J.K. Galbraith's thesis that big companies are planning not for maximum profit but for maximum growth has this very obvious limitation).

The State has almost no freedom. It cannot save because, apart from the profits of nationalized industries (which are usually negative), it has no income other than from taxation. But if it overtaxes its population one year, so that it has a budget surplus, this will not necessarily benefit the population in the next year. Unless it is invested wisely, it means only that private consumption and investments have been cut down in that year, at the expense of economic growth. For instance, if the State foresees that, say in 10 years time, its aged, non-earning population will increase, it can hardly stock canned foods and clothing for them. These will have to come out of the production of the working part of the population in ten years time. Nor can the State put its tax-savings into private enterprises, like the individual who wants to save. This would be just pumping back the money where it came from. *The State must invest,* and it must invest in projects which private enterprise would not undertake, because they are not profitable in the ordinary sense, such as roads, schools, hospitals, homes for the aged. *Ipso facto* Governments cannot shed their responsibility, by trusting the economic wisdom of others, like the private individual, and to some extent even the big company. It must make its own decisions, which means that it must foresee the future.

Add to this that, in our time, the responsibilities of governments have increased enormously, while taxation has practically reached its limit. To cover its expenditures, the British Government has in the past fiscal year borrowed money to the extent of £ 1,331 million, thereby contributing dangerously to inflation. According to moderate estimates, the United States Government would have to spend about 20 billion dollars annually, for many years, in the fight against poverty, especially negro poverty. But it is impossible to increase taxation to such an extent, and the Antipoverty Program, I understand, will run at about one-tenth of this, at the (almost certain) risk of further heavy riots.

From this it might appear that what I have asked for in the beginning is an impossible " counsel of perfection ". How could a Government play safe, how can it avoid unforeseeable dangers, if financial straits force it to run into almost certainly foreseeable grave dangers? The financial problem must be solved first, before anything else.

A Suggestion

I consider this problem is so serious that, with all due diffidence and apologies for my amateur status, I wish to offer a suggestion. Let me first define my terms. I want to make a sharp distinction between the real economic processes, that is to say the production, manipulation and consumption of material goods, and the symbolic operations in ledgers which accompany this process, which I call financial. It is my contention that there is no *economic* obstacle even to the most far-reaching and generous future-oriented plans of governments in the highly industrialized Western countries. With modern technology the potential productivity of our industries is so enormously greater than the actual level (even in the United States), that a great part (perhaps 25%, perhaps even more) of the national effort could be directed into " non-productive " but *vital* projects, without decreasing private consumption, without even interfering with its growth. This is my contention, as a technologist, after many discussions with fellow-technologists. The obstacles are only financial – and of course psychological !

The psychological obstacles are legion ; the lack of confidence on the part of the bankers, of the general public, of the workmen and the Trade Unions, not to mention the revolt of the young people, which has raised its head so alarmingly in recent months. I wish to deal only with the bankers and the general public's very understandable mistrust of government policies. Credit is mainly a matter of confidence. Nowadays there is so little confidence in governments, that everybody tries to get rid of Government Bonds. Yet there is so much loose cash and credit that new issues of stocks of reliable companies are usually 20 times oversubscribed. There are far too few issues ; the general public, in order to safeguard itself from inflation, has driven the share index to a height at which good companies pay 1% dividends or less.

This rather desperate situation encourages me to make a suggestion, for what it is worth. Let the governments raise money for their *vital* enterprises, not by increased taxation, not by borrowing, but in the stock market, by issuing a new type of bonds. These shall have no nominal value fixed for ever, but shall be redeemable (after a minimum number of years), at a value corresponding to the *current industrial index*, and they shall pay a dividend equal to the average of industrials. These will therefore be safe investments for those many members of the public who buy stocks and shares not for gambling, but to safeguard their savings from inflation. Their money will be as safe as if they had invested in Unit Trusts. These issues could be even more attractive by making them redeemable without capital gains tax. Their redeeming would, of course, throw a burden on the future, but who else can pay for the future if not the future? I expect that such issues would draw a considerable part of money away from insurance companies; on the other hand, they would have an anti-inflationary effect, because they would prevent the public from driving private stocks to insane heights. Insurance companies, which now often have great difficulties in investing, could also safely invest in them.

I want to leave it to others to devise safeguards so that the money raised in this way shall not be used for armaments, for paying new hordes of civil servants or for helping the governments out of acute shortages, but only for vital enterprises, such as roads, ports, public transport, antipollution measures, schools, hospitals, town development, homes for the aged, modernizing nationalized industries, and in particular, the war against poverty.

There is a related consideration of some importance which I want to put to discussion. One may agree or not with J.K. Galbraith's contention that *power* in the new industrial state is concentrated in the big companies, but one cannot dispute that they have cornered a considerable part of the talents and energy available. Under the simpler conditions of the 19th and early 20th century these could find full outlet in profitable enterprises. But now when *vital* projects have emerged which are *not* profitable in the ordinary sense, these talents are often barred from the *planning*, which is usually left to the less efficient machinery of the State, even if the execution of the project is farmed out to the companies. As an example, in Britain the development of atomic power was handled by a Government Establishment, which has now outlived its usefulness, but which cannot be easily disbanded. In the United States atomic power was more successfully developed by giant companies, but these same companies are now barred from such vital new projects as urbanization schemes or rapid inter-city transport, partly because these are not always profitable, partly also by the Anti-Trust Law. It is not my business to propose changing laws, but I think that the success of a financing scheme such as I have suggested would be greatly enhanced if the public knew that the projects would be handled with the same efficiency as the big companies achieve in their own business, and that the best talent in the country is watching over them. Of course, for reasons well known, this" best talent " also needs watching, but this we can safely leave to Congress and the various national Parliaments.

So far I have talked only of the *internal* economy of states ; how to save themselves from the trilemma of overtaxation, inflation and neglecting the vital necessities of the future. But we know very well that equally bad or even worse situations have arisen in trading with foreign countries. The old safety device of hoarding gold, which the Ministers of Finance have followed since the time of Colbert, has now become ridiculously inadequate. The total gold hoard of the United States is less than 1.4% of their Gross National Product, and the hoard of Britain is in fact negative. The relatively large hoard of France in gold and foreign assets may be only just enough to tide them over the heavy losses of the present year. The greatest peril is not that these countries, so rich in world standards, may have to tighten their belts a little as far as imports and foreign travel is concerned, but that they may have to cut down Foreign Aid to an extent which threatens starvation, revolutions and chaos in the underdeveloped parts of the world. It is a crying scandal that a rich country such as the United States, with an almost unlimited productivity, cannot give more than a negligible fraction of its wealth to the poor countries without endangering its currency and its all-too-small gold hoard. (The two billion dollar Foreign Aid, which is all the U.S. will be able to spare this year, amounts to less than one and a half minutes work per day for the American worker !) This cannot be remedied until gold is demonetized. Governments cannot play safe so long as irresponsible individuals can " play safe " by hoarding gold.

Planning for Flexibility

I originally intended to limit my contribution to this topic, but the clear and present danger in which our world finds itself made me preface it with some suggestions for breaking the present confused deadlock.

Can planning ever become an exact science and, if it can, would we be satisfied with it? The attitude of men to planning is as ambivalent as it is to the future. We dread the uncertainties of the future, but we should hate to know it exactly, in advance. Man cannot live without hope, and hope means uncertainty. Even those extremely security-minded young men, who will enquire about the pension scheme as soon as they enter their first employment and who will take out a good insurance, are likely to gamble a little. Even the communist countries had to make an allowance for this human trait by introducing premium bonds (1).

Human nature is such that a person will object not only to bad planning, but also to " good " planning, if this means being told by others what is good for him. This has long been recognised by liberal minded people who wished to reconcile the advantages of planning with the fundamental values of a liberal democracy. (For instance R.H.S. Crossman, in " Planning for Freedom ", Hamish Hamilton, London, 1965). We must always keep this in mind. In particular we must respect the freedom of the planners of tomorrow, who may be in a better position than we to take account of the wishes of the population of tomorrow.

If we want flexible, adaptable institutions, we must have, first of all, adaptable men and women. I have already mentioned the rigidity of government establishments which are there to stay after they have outlived their usefulness, like the " temporary " buildings in Constitution Avenue. Private enterprises are more flexible, chiefly because they do not give such absolute security of tenure, but they cannot guarantee adaptability if they are staffed by people who learned their business 10, 20 or 30 years ago, and if the influx of young people has stopped for lack of growth. One often hears complaints about the slow adaptation of human institutions, but they derive their rigidity from their individual members. In planning we seldom face lead times of more than 10 years. Even skyscrapers are not supposed to stand for more than 25 years. Yet, when we turn out, for instance, an electronic engineer from a university, he may well be under the delusion that he can remain an electronic engineer for 40 years. He might conceivably remain one, – but only if Parkinson's Law is stretched to the limit!

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(1) Milton Friedman and L.J. Savage, in a most interesting essay, " The Utility Analysis of Choices Involving Risks ", (Readings in Price Theory, Allen & Unwin, London, 1951, p.57-96,) have shown that taking out an insurance *and* gambling is not as irrational as it may seem, because using the von Neumann-Morgenstern concept of utilities one can account for it by a utility *vs.* income curve which is concave to the income axis at small incomes, convex at large ones. Whether this is considered as rational or not is a matter of taste ; at any rate it shows that behaviour is *consistent*.

For some time, though not for ever, we must expect technology to progress so fast that " expert " knowledge loses most of its value in 10 years or less. We must therefore dismiss the old belief that knowledge is something which can be acquired once for all at a young age. Learning must become a lifelong pursuit.

And not only for professional experts! It is even more important that the common man or woman shall be prepared to change jobs and habits in middle life. It must be clear to everybody who has a notion about the enormous potential productivity of modern industry, that the number of people usefully employable in production is steadily decreasing, in a steadily increasing production. Parkinson's Law is achieving miracles, not only in the offices, but also on the shop floor, but it cannot conceal this for ever. The economy may be able to bear large scale unemployment, (even with full pay for the unemployed), but human psychology cannot. Until we manage to educate a generation quite different from ours, we must accept, with C.E.M. Joad that " Work is the only occupation yet invented which mankind has been able to endure in any but the smallest possible doses " (1).

But where shall these masses go who drop out of the production lines ? The answer is evident ; into the services, from the catering to education. Modern technology could perfectly well provide completely automated hotels, but could anybody be happy in such a cafeteria-civilisation ? The ridiculous stigma, which still attaches to personal service from the times when it was little better than slavery, must be removed. And education is the only mass-industry capable of taking up the millions who will become redundant in the offices once Parkinson's Law will fail to keep in step with the computers, and which in addition is a vital necessity in any mature society on a high cultural level.

We do not know whether a stable human society is possible on a high level of material comfort, without the necessity of hard work to give it cohesion. The experiment could never be tried until the arrival of modern technology. The only experiment in the past, the "*panem et circenses*" solution of Imperial

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(1) Joad, C.E.M., *Diogenes, or the Future of Leisures*, Kegan Paul, Trench Trubner & Co, London, 1928, p.19.

Rome is one which we do not want to repeat. We do not know whether we can succeed, but if ever we get there, it will be by the way of lifelong education for everybody. If we want to plan for freedom and safety, we must plan for this on a scale never before attempted.

MATHEMATICAL PART

I have discussed the problem of planning for safety and freedom in general, human terms. I will now take it up again in abstract, mathematical terms.

Bad planning can produce desperate situations, and even planning which is not catastrophically bad might pre-empt to a highly objectionable degree the freedom of choice of the successors. In our epoch of rapid material progress and constant change, planning has become indispensable, but it may well be asked whether our powers of foresight have reached an adequate degree of development? Hardly anybody would dare to answer this question in the affirmative. But even if we had the foresight and wisdom to plan the affairs of our successors as *we* think will be the best for them, have we got the right to do so if thereby we restrict their freedom of choice?

Here is a dilemma which can never be completely resolved. The best we can do is to strike a reasonable compromise between the interests and the freedom of one generation and the next ; a compromise between rigid planning and " planning for freedom ".

The dangers of rigid planning are symbolically illustrated in Fig. 1. At a time $t=0$ a decision has been taken to drive the system in a certain direction, avoiding dangers which have been visible at that time. At some later time $t=\tau$ one finds oneself confronted by a danger which was unforeseen and unforeseeable at $t=0$. This is the sort of situation which can give rise to panicky decisions.

How can one avoid this? The commonsense answer is of course : go slow, look out all the time, and be always ready to change your policy. Do not make plans beyond your foresight! This is of course cheap advice, moreover one which it is not always possible to follow. Can we not do a little better? Though we cannot of course look far into the future, can we not foresee a little of the freedom for planning of what I will call for simplicity the " next generation ", though it may be ourselves in only a few years time? Giving them a reasonable latitude of steering may be the next best thing to preparing for dangers which we cannot foresee.

It will be useful to make this more precise by a diagram of the events in system space, such as shown in Fig. 2. This in an adaptation of what in

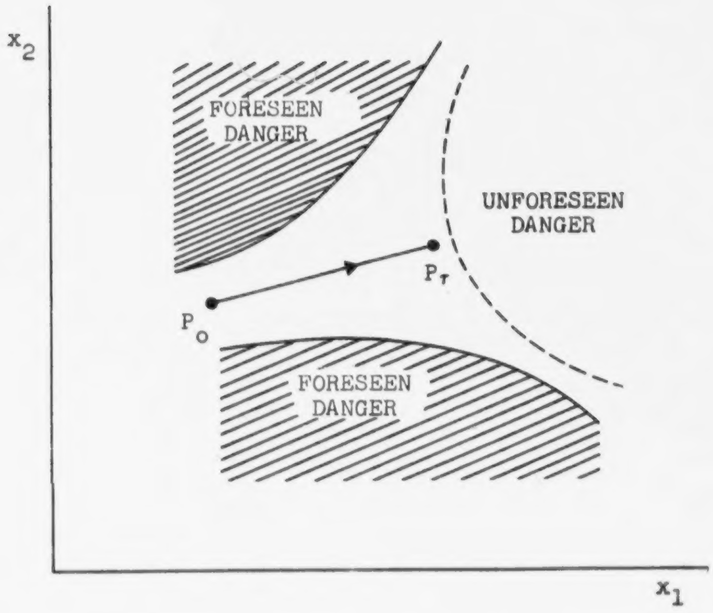
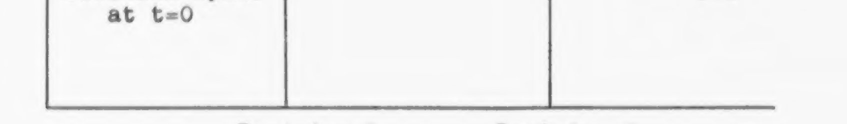

x_2
FORESEEN DANGER
UNFORESEEN DANGER
P_τ
P_o
FORESEEN DANGER
x_1

FIG. 1. RIGID PLANNING


x_2
Decision made at t=0
(Vector δx_{1o})
Decision space at t=0
Decision space at t=τ if the decision 1 has been made at t=0
Decision 1 t = 0
Decision 2 t = τ
x_1

NOT ALL ECONOMIC OR SOCIAL VARIABLES CAN BE INSTANTANEOUSLY CHANGED BY AN ACT OF WILL, BUT THEIR RATES CAN BE. x_1, x_2 ARE SUCH "FREE" VARIABLES.

FIG.2. DECISION TAKING

dynamics we call the " phase space ". In dynamics this is the joint space of the coordinates of the system, plus the associated momenta. It is " complete " in the sense that through any point $x_1..x_n$ there is only one system trajectory, i.e. the initial conditions are sufficient to determine the future of the system. If we want to adapt this to economic or social problems, we must make two modifications. First, it is of course obvious that the trajectories cannot be extrapolated far into the future. They are predictable only for a short stretch. Second, some economic and social variables can be modified to some extent at any instant by an act of will. This is not of course always possible. No act of will can change instantaneously for instance the number of houses, but it may be possible to change the rate of house building. It is of course much the same when driving a car ; no act of will can change the instantaneous position or the instantaneous tangent, one can change only the curvature. We help ourselves just as we help ourselves in dynamics : We take as variables $x_1..x_n$ not just quantities, but also the rates and the rates of rates etc. For simplicity of illustration in Fig. 2 and also in the following figures I have taken coordinates x_1,x_2 which represent what one could call " free "variables, so that one can change their values as good as instantaneously by an act of will.

To simplify matters further, I have here assumed that decisions are not taken continuously, but at certain times 1,2 .. separated by a " lead time " τ . The position is then as follows. At $t = 0$ the system has reached a certain point. At this point we are free to change the initial conditions by small quantities, $\delta x_1 .. \delta x_n$ is a small " decision space ". Once a decision has been made, which is described by a " decision vector " ($\delta x_1.. \delta x_n$) the system moves to a certain point in a time τ,at which a further decision can be taken.

It is evident that this is not the most perfect mathematical representation of social or economic events. In a more complete picture we would have to consider every one of the trajectories starting at $t = 0$ as a cone of probabilities, of zero thickness at $t = 0$ but gradually widening and overlapping. But the representation which I have chosen is by far the more convenient for a first attack on these complicated problems, because it allows us to use the apparatus of ordinary differential equations instead of partial differential equations for the propagation of probabilities, which we could not formulate anyway in most practical cases.

We can now formulate our problem. In a general form, it is a compromise between our freedom of planning, at $t = 0$, to reach certain objectives, and the corresponding freedom of the next generation at $t = \tau$. But I propose to restrict the scope of the discussion, by considering only the extreme case : that we are planning for the *maximum freedom of the next generation of planners.* I do not suggest for a moment that this is a reasonable policy. Claude Shannon introduced this in 1950 as a strategy for instructing a chess-playing robot : maximum freedom after the next move, and in fact my approach was inspired by him (1). Social or economic planning is of course very different from a game of chess, and in our case I propose considering this policy only because it will help to clear ideas.

In order to formulate the problem of planning for freedom, we must first define freedom. In a general way this must be defined as *some measure of the effectiveness of decisions which one is allowed to take at a certain time.* I emphasize that it is not the latitude for decision which one has at $t = 0$, but their *effectiveness* at $t = \tau$ which is a proper measure of the freedom of the planners at $t = 0$. The freedom of the planners at $t = \tau$ is then similarly defined, with a time shift.

The Phase Volume as a Measure of Freedom

A first measure which immediately suggests itself is the phase volume, because by Liouville's General Theorem this obeys particularly simple dynamic laws (2).

By introducing a sufficient number of variables a system of ordinary differential equations of any order with time as free variable can be reduced to a form

$$\frac{dx_i}{dt} = f_i(x_1 \ldots . x_n, t) \qquad 1.$$

that is to say, to equations of the first order. The f_i are the rates of change of the variables x_i. In a short time interval τ the variable x_i which was x_{io} at $t = 0$ will change to

$$x_{i\tau} = x_{io} + \tau f_i \qquad 2.$$

At time $t = 0$ we apply variations δx_i to the variables x_i, so that they fill a certain small space volume. From here on we restrict the suffix " i " to mean only the " free " variables, which can be changed at $t = 0$. By the transformation 2. this space D_o will be transformed into

$$D_\tau = \frac{\partial(x_1 \ldots . x_n)}{\partial(x_{10} \ldots . x_{n0})} D_o \qquad 3.$$

(1) Shannon, Claude E., First International Symposium on Information Theory, London 1950.

(2) Liouville's original proof, given above, is reproduced in E. Goursat, *Cours d'Analyse Mathématique*, Gauthier-Villars, Paris, 1948, Vol.2, p.246.
I am much obliged to Dr. J. Fronteau of CERN, Geneva, who has let me see his CERN Report 65-38/MPS, Nov.12, 1965 " Le Théorème de Liouville et le Problème Général de la Stabilité " and also his most interesting internal Memo MPS/Int. MU/EP 65-5, May 26, 1966 " L'Entropie et la Physique Moderne ".

where the factor is the Jacobean of the x_{io} with respect to the x_{io},that is to say

$$\frac{\partial(x_1 \ldots\ldots x_n)}{\partial(x_{10} \ldots\ldots x_{n0})} = \begin{vmatrix} 1+\tau\frac{\partial f_1}{\partial x_1} & \tau\frac{\partial f_1}{\partial x_2} & \ldots & \tau\frac{\partial f_1}{\partial x_n} \\ \tau\frac{\partial f_2}{\partial x_1} & 1+\tau\frac{\partial f_2}{\partial x_2} & \ldots & \tau\frac{\partial f_2}{\partial x_n} \\ \cdot & \cdot & \cdot & \cdot \\ \tau\frac{\partial f_n}{\partial x_1} & \tau\frac{\partial f_n}{\partial x_2} & \ldots & 1+\tau\frac{\partial f_n}{\partial x_n} \end{vmatrix} \qquad 4.$$

To the first order in τ this is

$$1 + \tau\left(\frac{\partial f_1}{\partial x_1} + \frac{\partial f_2}{\partial x_2} + \ldots + \frac{\partial f_n}{\partial x_n}\right) = 1 + \tau \, div \, \underset{\sim}{F} \qquad 5.$$

where $\underset{\sim}{F}$ is the vector with the components f_i. Hence

$$D_\tau = (1 + \tau \, div \, \underset{\sim}{F}) D_0$$

or

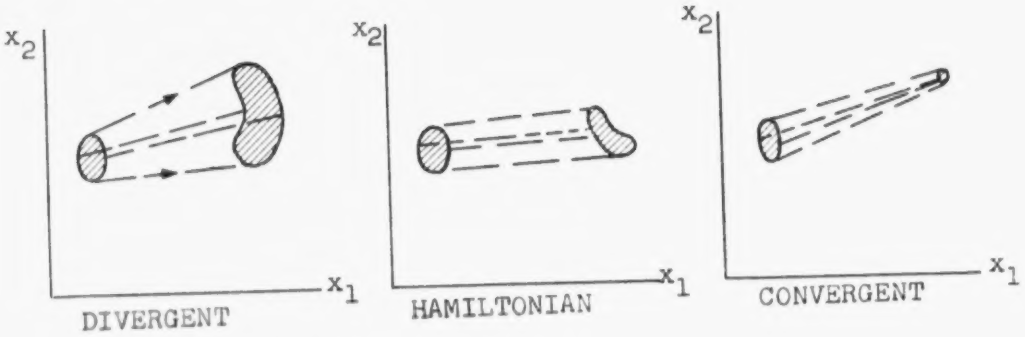
$$\underline{\frac{d}{dt} \log D = div \, \underset{\sim}{F}} \qquad 6.$$

This is Liouville's general theorem, illustrated in Fig.3 The $\underset{\sim}{F}$–vector is the " velocity vector " in the phase space $x_1 \, ..x_n$, but Liouville's theorem applies also to any subspace, in our case to the subspace of the " free " variables , those which can be varied at will at the decision points. The growth rate of the logarithm of the phase volume D is equal to the divergence of the $\underset{\sim}{F}$–vector. Log D can be called the " entropy " of the initial latitude, (c.f. J. Fronteau, *l.c.)*, but we shall not go into the enumeration of the similarities and differences compared with the quantity which goes by this name in statistical mechanics.

Three cases are illustrated ; div $\underset{\sim}{F}$ positive, div $\underset{\sim}{F} = 0$, and div $\underset{\sim}{F}$ negative. In the first case the phase volume grows, in the third case it decreases, in the case of zero divergence it remains constant. This can be called the " Hamiltonian " case, because it is this case which is considered in the statistical mechanics of systems subject to Hamilton's canonical equations (1).

(1) In Hamiltonian dynamics the terms in the divergence drop out in pairs ; the rate of change of each coordinate annuls that of its associate momentum. But this does not apply to all subspaces. If we apply our considerations to a dynamical system, we must consider the coordinates as unfree, but the momenta are free, because they can be changed instantaneously by collision processes, hence the divergence in the subspace of the momenta or velocities can be non-zero.

The general condition for the vanishing of div *F* is that the vector *F* must be the divergence of an antisymmetric tensor. In three dimensions this means that *F* must be the curl of a vector.


x_2
x_1
DIVERGENT
x_2
x_1
HAMILTONIAN
x_2
x_1
CONVERGENT

DYNAMICAL EQUATIONS

$$\frac{dx_i}{dt} = f_i(x_1 \ldots x_n, t) \qquad (f_i = \text{rate of change})$$

Take any small phase space volume D, centering on $x_1, \ldots x_n$. This will change at the rate

$$\frac{d}{dt} \log D = \frac{\partial f_1}{\partial x_1} + \ldots + \frac{\partial f_n}{\partial x_n} = \operatorname{div} \underset{\sim}{F}$$

In the special case of Hamiltonian dynamics $\operatorname{div} \underset{\sim}{F} = 0$ and D is an invariant of motion.

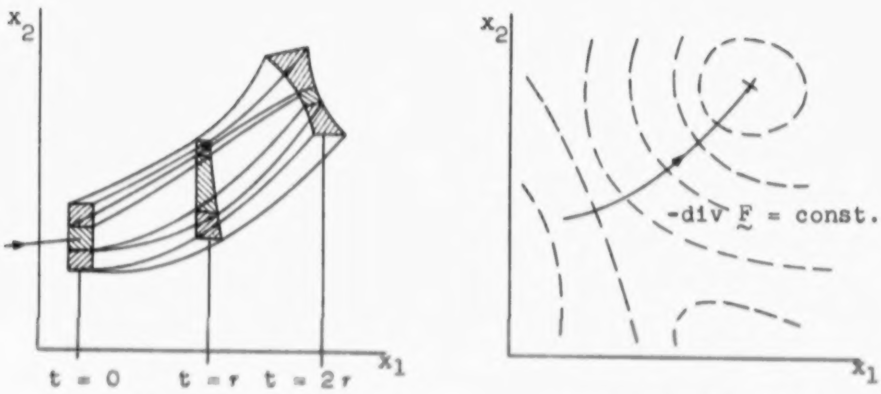
Fig. 3. LIOUVILLE'S GENERAL THEOREM

If we adopt the phase volume as a measure of freedom, Liouville's theorem gives one way of formulating our problem quantitatively. At time $t = 0$ we have a certain decision volume D_0 at our disposal. Our freedom is not this volume, but its *effectiveness,* that is to say the volume which will be accessible at time $t = \tau$ if we take a decision inside D. If now we want to maximize the freedom of our successors at $t = \tau$, we must make at $t = 0$ such a decision that the position $x_1 .. x_n$ enables our successors to utilize *their* decision volume, say D_τ, in the most effective way. This means that at $x_{1\tau} .. x_{n\tau}$ the divergence of $\underset{\sim}{F}$ must be as large as possible, or at least as little negative as possible.

It must be emphasized that D_τ, the decision volume at $t = \tau$ need *not* be the volume to which D_0 has grown in the time τ. What decisions the successors will consider as admissible must be left to them, and what they consider as admissible is certainly *not* a measure of their freedom. It is just in desperate situations that people will contemplate the largest excursions from the *status quo* : desperate remedies. The measure of their freedom which I propose is such that, in *whatever volume* they make their choice, it must be as effective as possible, that is to say a large volume of the phase space must be accessible from it.

Fig.4 illustrates a few of the great variety of cases which can arise if the time interval between choices is long. The decision volume at $t = 0$ is shown divided into three sections. The middle one allows the planners at $t = 0$ the greatest choice, because it has the widest initial divergence. But in fact it gives the planners at $t = \tau$ the least effectiveness, because after a further interval τ the trajectories converge to a small volume. The most advantageous choice is in the upper third. It is advantageous for the planners at $t = 0$, because the trajectories converge, so that errors in their choice have little effect on the result. It is also advantegeous for the planners at $t = \tau$, because from here on the trajectories diverge. This is an ideal case, but it will be rare, and what is worse, impossible to foresee.

Consider the data which have to go into such a forecast. The rates $dx_i/dt = f_i$ at $t = 0$ are empirically known. In order to calculate the divergence of $\underset{\sim}{F}$ we must also know the partial derivatives $\partial f_i / \partial x_i$, that is to say, the derivatives of the rates with respect to the variable in question. Knowing these is a *sine qua non* postulate for any sort of planning, but it must be admitted that they will be known only in rather rare cases. They may be known if one has a causal insight into the social or economic mechanism, or a model of it, which allows varying the variables. They can be hardly known by the empirical or "historical" approach, by looking at similar cases in the past. It is most


x_2
x_1
$t = 0$
$t = \tau$
$t = 2\tau$
x_2
$-\text{div}\ \underline{F} = \text{const.}$
x_1

FINITE LEAD TIMES

THE EXAMPLE SHOWS THAT SAFEST (CONVERGING) PLANNING AT $t = 0$ CAN BE COMPATIBLE WITH MAXIMUM FREEDOM OF CHOICE AT $t = \tau$.

SHORT LEAD TIMES

RULE: STEER THE SYSTEM IN THE DIRECTION OF THE STEEPEST SLOPE OF div $\underline{F}$

PARADOX: ONCE A MAXIMUM OF div $\underline{F}$ IS REACHED THE BEST CHOICE IS TO STAY PUT.

FIG. 4. GROWTH RATE OF PHASE VOLUME AS CRITERION OF PLANNING FOR FREEDOM

unlikely that a precedent will be found in which only one variable was varied, and all other things were the same as in the present situation. Nevertheless we can assume that a reasonable estimate of div $\underset{\sim}{F}$ can be found, – otherwise there will be no planning at all. But if it comes to predicting the future of the divergence, the difficulties tend to be insuperable.

Let us predict the divergence after a short time τ. This is

$$div\,F_\tau = div\,F_0 + \tau \frac{d}{dt}\,div\,\underset{\sim}{F} = div\,F_0 + \tau\left(\frac{\partial}{\partial t} div\,\underset{\sim}{F} + \sum_i \frac{\partial\, div\,F}{\partial x_i}\delta x_i\right) =$$

$$= div\,F_0 + \tau\left(\frac{\partial}{\partial t}\,div\,\underset{\sim}{F} + \sum_i \sum_j \frac{\partial^2 f_i}{\partial x_i\,\partial x_j}\,\delta x_i\right) \qquad 7.$$

Only the last term depends on the decision (δx_i) taken at $t = 0$ and this must be maximized, with the assumption of some limiting condition. The simplest is to assume that the decision space at $t = 0$ had an ellipsoidal boundary

$$\sum_i g_i\,(\delta x_i)^2 = const. \qquad 8.$$

As the last term in eq. 7 is proportional to the (δx_i) vector, the largest values will be for decision points on the boundary. Maximization gives

$$\delta x_i = const.\ \frac{1}{g_i}\,\frac{\partial}{\partial x_i}\,div\,\underset{\sim}{F} \qquad 9.$$

By introducing the condition 8. we have lost an advantage of the phase volume criterion, but it is only an apparent advantage. In applying Liouville's theorem 6. there is no need to bother about the dimensions of the variables or about their relative importance. All terms in div F have the dimension t^{-1}, and a proportional increase by, say, 10% in any one variable increases (d/dt)log D by the same amount. This is to some extent rectified by the condition 8. We can for instance define the weights g_i by

$$1/g_i = \text{relative importance} \times (\text{max.allowable } \delta x_i)^2$$

and eq. 9 can then be expressed by the rule Change your initial conditions proportionally to their relative importance and to the effect which they have on the divergence. This becomes particularly simple if all the weights g_i are equal : In order to obtain maximum freedom for the next choice, (after a *short* time interval τ,) *steer the system in the direction of the gradient of div* $\underset{\sim}{F}$, or as close to it as you can, if restricted by other conditions.

This is a simple and natural rule, unfortunately not a very practical one, because in order to implement it we must know all the second partial derivatives of the rates f_i, and this would require a more reliable model than we can expect to possess. Nevertheless it is interesting to think of some of the consequences of this rule, as illustrated in Fig.4. Assume that we have followed the rule and have climbed up to a maximum of div F. Once we have done this, and given our successors the change of maximum freedom – they would be wise not to use it, because any departure from the maximum will decrease the freedom! (They will be able to follow this rule only if at the maximum of div F all the rates f_i have gone to zero, otherwise the system will overshoot the maximum, and will have to oscillate around it.).

This curious paradox is not quite unfamiliar. We have heard something similar in many discussions between the West and the communist East. When reproached that the voters have no freedom to vote for an alternative party, the reply of the communists was that they would not wish to, because they knew that they were in the best hands! The novelty in the present paradox is only that the maximum in question, where it is best not to exercise the freedom, is not a maximum of material goods, social justice etc, but the maximum of *freedom itself*. Of course a maximum in *n* dimensions is a very exceptional thing, and the case when it can be reached without having to overshoot it is even more exceptional, but it cannot be denied that there is something fundamentally paradoxical in the concept of freedom.

The Action Radius as a Measure of Freedom

Though the phase volume as measure of freedom is *prima faciae* natural and attractive, it is somewhat disappointing because it does not lead to a rule which can be quantitatively implemented in most practical cases. I propose therefore considering a second approach, based on the concept of the " action radius ". This may be defined by

$$R^2 = \sum_1^n g_i (\delta x_i)^2 \qquad 10.$$

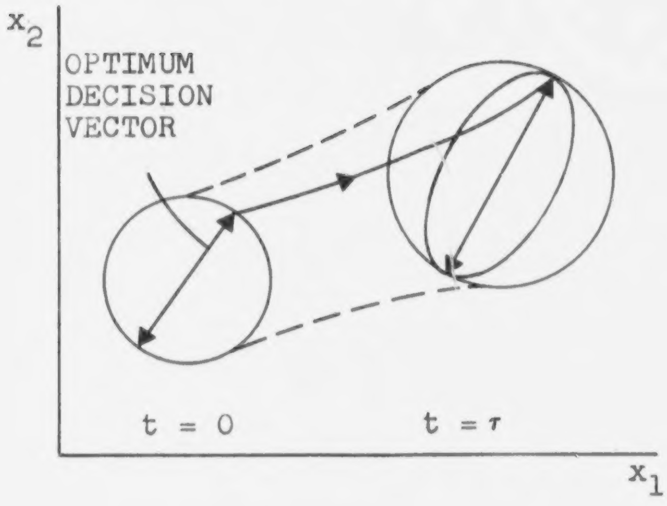
The weights g_i must be all positive, and have such dimensions that all terms in 10. have the same dimension. R is constant on an ellipsoid (see Fig. 5):

$$\sum_1^n g_i (\delta x_i)^2 = const.$$

Allotting the proper weights to the variables is of course a matter of agreement. One can for instance agree that δx_i must be in the limits $\pm\delta x_{i\ max}$, in which case it is the most convenient to give the weights the values

$$g_i = \frac{1}{(\delta x_{i\ max})^2}$$

Assuming that an agreement about the definition has been reached, let us follow the action radius during a short time τ. This will change the δx_{io} into


x_2
OPTIMUM
DECISION
VECTOR
t = 0
$t = \tau$
x_1

DEFINITION OF ACTION RADIUS R

$$R^2 = \sum_{1}^{n} g_i \, (\delta x_i)^2$$

GROWTH RATE OF ACTION RADIUS

$$\frac{d}{dt} \log R = \frac{\sum \sum \left(g_i \frac{\partial fi}{\partial x_j} + g_j \frac{\partial f_j}{\partial x_i} \right) \delta x_i \, \delta x_j}{\sum g_i \, (\delta x_i)^2}$$

THE GROWTH OF THE ACTION RADIUS

AS CRITERION OF PLANNING FOR FREEDOM

FIG. 5.

$$x_{i\tau} = \delta x_{io} + \tau \delta f_i = \delta x_{io} + \tau \sum \frac{\partial f_i}{\partial x_j} \delta x_{jo} \qquad 11.$$

and R according to

$$R_\tau^2 = R_o^2 + 2\tau \sum g_i \, \delta f_i \, \delta x_{io} + \text{terms of order } \tau^2 =$$

$$= R_o^2 + 2\tau \sum g_i \, \delta x_{io} \sum \frac{\partial f_i}{\partial x_j} \delta x_{jo} + \ldots \qquad 12.$$

Hence $$\lim_{\tau=0} \frac{R_\tau^2 - R_o^2}{2R_o^2} = \frac{1}{2R^2} \frac{dR^2}{dt} = \frac{d}{dt} \log R =$$

$$= \frac{\sum g_i \, \delta f_i \, \delta x_i}{\sum g_i (\delta x_i)^2} = \frac{\sum\sum g_i \frac{\partial f_i}{\partial x_j} \delta x_i \, \delta x_j}{\sum g_i (\delta x_i)^2} \qquad 13.$$

where for simplicity we have left out the suffix o. In symmetrical form, counting each pair i,j only once

$$\frac{d}{dt} \log R = \frac{\sum\sum \left(g_i \frac{\partial f_i}{\partial x_j} + g_j \frac{\partial f_j}{\partial x_i} \right) \delta x_i \, \delta x_j}{\sum g_i (\delta x_i)^2} \qquad 14.$$

This is the law for the dynamic growth of the action radius, a counterpart of Liouville's equation. Compared with eq. 6 it has the advantage (for our special problem,) that the growth rate of log R is not a function of the starting point alone, but also a function of the *direction* of the decision vector (δx_{io}). We can of course just as little maximize the prospective growth of R for finite times as we could do with D, without postulating a practically impossible degree of foresight. But we can at least maximize it for short times.

Maximizing the fraction 14. in terms of the δx_i gives the equations

$$\left(\frac{\partial f_i}{\partial x_i} - \Lambda \right) \delta x_i + \sum_{j \neq i} \frac{1}{2} \left(g_i \frac{\partial f_i}{\partial x_j} + g_j \frac{\partial f_j}{\partial x_i} \right) \delta x_j = 0 \qquad 15.$$

where Λ is a Lagrangian multiplier. The compatibility of these equations gives the determinantal equation

$$\begin{vmatrix} g_1 \left(\frac{\partial f_1}{\partial x_1} - \Lambda \right) & \frac{1}{2} \left(g_1 \frac{\partial f_1}{\partial x_2} + g_2 \frac{\partial f_2}{\partial x_1} \right) & \cdots\cdots & \frac{1}{2} \left(g_1 \frac{\partial f_1}{\partial x_n} + g_n \frac{\partial f_n}{\partial x_1} \right) \\ \frac{1}{2} \left(g_2 \frac{\partial f_2}{\partial x_1} + g_1 \frac{\partial f_1}{\partial x_2} \right) & g_2 \left(\frac{\partial f_2}{\partial x_2} - \Lambda \right) & \cdots\cdots & \frac{1}{2} \left(g_2 \frac{\partial f_2}{\partial x_n} + g_n \frac{\partial f_n}{\partial x_2} \right) \\ \cdot & \cdot & \cdot & \cdot \end{vmatrix} = 0 \qquad 16.$$

As the matrix is symmetric, the roots of eq. 16, $\Lambda_1, \Lambda_2 \dots \Lambda_n$, which are its eigenvalues, are all real. The values

$$\frac{d}{dt} \log R = \Lambda_k$$

give directions $\delta x_{1k} \,..\, \delta x_{nk}$ in which the growth of the action radius is indifferent to small variations, but they are not necessarily extrema. There will be, however, at least one eigenvalue which is the largest positive or the least negative of the Λ_k, and this is then the optimum choice with the " action radius " measure of freedom. It may be noted that the optimum direction, which is obtained by substituting the largest positive or least negative of the eigenvalues into the equations 15 is defined only up to its sign, but in practical cases there will be hardly any doubt which of the two signs to choose.

Summing up, the " action radius " measure of freedom appears more practical than the " phase volume " definition, because it requires only the knowledge of the first derivatives $\partial f_i / \partial x_j$ of the rates f_i for computing an optimum strategy of planning for freedom of choice, and this is the very minimum which one requires for any sort of planning.

So far I have discussed only strategies for maximum freedom of choice and have entirely left out what is the usual purpose of planning ; the maximizing of one or several quantities which are functions of the variables $x_1 \,..\, x_n$. A strategy which deserves the name of " open-ended planning " must be a compromise between the usual aims, *plus* the new one of reserving a reasonable amount of freedom for the next generation of planners. I have also left out the usual limitations of planning, such as arise for instance in linear programming. It was not and could not be my purpose to give a full discussion of this almost unlimited field. All I wanted to do was to remind the planners : " Do not forget the freedom of those who come after you ! "

NOTE. Readers may have noticed that the problems which I have discussed here have many similarities to the " Dynamic Planning " of Richard Bellman and other authors. There is the formal difference that I have not distinguished between " state variables " and " decision variables ". I have considered the decision variables as variations of the state variables. There is however the essential difference that I have considered " freedom of choice " as the success criterion, while this concept is quite absent in Dynamic Planning.

A LANGUAGE FOR ORGANIZATION DESIGN

by

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and

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INTRODUCTION

Managers need improved methods for designing organizations which are best suited to accomplish specified objectives. Several factors combine to make the problem of what the organization should be, rather than how to get the most results from an existing organization, a high priority issue for today's executive. Rapid changes in customer needs and product-process technologies require organizations that are flexible and responsive. Diversity of product lines and multinational scope of operations require organizations which are efficient in spite of their size and complexity. As the human resources of professional and managerial manpower are recognized as key corporate assets, forms which channel expert talents toward organizational goals are needed. Getting maximum payoff from the new management technology of computers and information systems requires new definitions of centralization, decentralization, and span of control. Realization of top management strategies for corporate growth and development creates organizational imperatives for setting up new businesses, divestment of old businesses, merging with other organizations, and formation of programs for new product research, development, and commercialization which cut across existing organizational boundaries.

Planners and managers constantly are changing their organizations in response to the above forces. For example, a survey of 61 companies, conducted by the National Industrial Conference Board, revealed four major trends in changing corporate structures (1) :

1. greater divisionalization plus decentralization
2. elaboration and changing roles of corporate staff
3. emergence of group executives
4. elaboration of the chief executive's office

Designs for these current organization changes draw upon several areas of business theory and practice. Layouts of plants and manufacturing processes use standard industrial engineering techniques. Organization charts build upon generally accepted principles of specialization, span of control, accountability, authority, and responsibility in the assignment and allocation of decisions. Job position descriptions are written, payroll and incentive schemes are established, and explicit styles of management are spelled out in policy statements with guidance from human relations, personnel management, and industrial relations experts. More recently, systems analysts use criteria for designing decision making, reporting, and order processing systems which take into account timeliness, accuracy, and cost of information appropriate to organizational needs.

(1) Stieglitz, H., *Organization Planning,* National Industrial Conference Board, New York, 1962.

A small body of research literature on organizational design also has emerged. See for example literature references (1), (2) and (3). (Reference (3) has an extensive bibliography of published research relevant to organization design.) One line of inquiry has been to use operations research models , such as Markov chains, queuing and learning theory, reliability models, and information theory concepts to describe certain internal operating characteristics of complex organizations. Another theme has been to categorize and more rigorously define what the problems of organizational design are, using systems analysis terminology. Further, some work has been done which combines economic theory with organizational principles in the formulation of models which explain how performance of simplified organizations would respond to alternative assumptions about market structure. Still other researchers have formulated and tested explanations of why organizations use particular information processing procedures for making decisions.

Mathematical programming techniques have been suggested as organization design tools in two ways which are particularly relevant to this paper. First, Sengupta and Ackoff have addressed the problem of how to assign decision-making activities and distribute constraints among various management levels in an organizational hierarchy so as to insure that outcomes of decisions made at each level are " optimum " from the viewpoint of the organization as a whole (4), (5).

Second, dynamic features of the assignment of individuals to tasks in an organization have been explored by Charnes, Cooper, and Stedry (6). They have extended a linear programming model to situations in which an initial assignment of an organizational participant to an activity alters characteristics of the individual as well as of the job. This formulation is suggested as a way of exploring alternatives to organizational designs which assume first a set of static, predetermined activity requirements, and then the assignment of available personnel to meet the given set of requirements. Full elaboration of this design conception would encompass provisions for changing job content,

(1) Carzo, R. and J. N. Yanouzas, *Formal Organizations: A Systems Approach,* Irwin-Dorsey, Homewood, Illinois, pp. 261-468.

(2) Cyert, R. M. and J. G. March, "Organization Design", in *New Perspectives in Organizational Research,* Cooper, Leavitt, Shelly (eds.), Wiley, 1964, pp. 557-566.

(3) Haberstroh, C. J. "Organizational Design and Systems Analysis", *Handbook of Organization,* March, J. G. (ed.), Rand McNally, 1967, pp. 1171-1211.

(4) Sengupta, S. S. and R. L. Ackoff, "Systems Theory from an Operations Research Point of View", *IEEE Transactions on Systems Science and Cybernetics,* Volume SSC-1, No 1, November 195, pp. 9-13.

(5) Ackoff, R. L., "Rouding Out the Management Sciences", *Columbia Journal of World Business,* Winter 1966, pp. 33-36.

(6) Charnes A., W. W. Cooper, and A. Stedry, *Multidimensional and Dynamic Assignment Models with Some Remarks on Organization Design,* Management Sciences Research Report No. 124, Graduate School of Industrial Administration, Carnegie-Mellon University, Pittsburgh, Pennsylvania, March 1968.

supervising subordinate relationships, setting up new jobs and eliminating existing ones; i.e., a methodology for designing internally dynamic organizations responsive to rapid changes in organizational environment and purpose.

Each of the above approaches from management practice and research is a relevant, although partial, organization design conception. Methods for synthesizing answers provided by various techniques of analysis into an overall statement of organizational form are, as yet, unavailable. A new conception which integrates physical, information, behavioral, and economic variables is needed which provides a comprehensive language to aid managers in selecting effective organization structures. Conflicts and interactions among major design variables must be recognized explicitly within a framework encompassing the organization as a whole. Evolutionary changes in organizations, while satisfactory in the past, are no longer adequate, because today's organizations must be redesigned with increasing frequency. Our purpose in this paper is to formulate a practical language for organizational design, and which permits simultaneous consideration of all relevant classes of variables and highlights tradeoffs among these variables for the designer-manager.

Our design language will be limited to purposive organizations. We define "purposive" to mean that there is an identifiable output which the organization seeks to produce efficiently, i.e., it seeks, over time, to maximize the output which can be produced for a given amount of resources, or to minimize the amount of resources needed to meet a specified demand for output. We recognize that organizations are distributed across a spectrum with organizational purpose dominant at one end and purposes of individual organizational participants dominant at the other. We shall operate at the former end of the spectrum, considering the dominant organizational purpose as the major determinant of structure and using the business firm as our example. The purposes of individual participants are modifiers of structure. They will enter into our conception as test of viability and influences of the degree to which an organization is efficient in seeking its purpose. Hence, balancing inducements the organization offers against contributions the participants make is a secondary design consideration, applied after a general organizational form is derived. Further, we shall not deal explicitly with notions of "informal" organization but shall assume that accommodations to personalities, styles, and limitations in the skills of individuals are made through adjustments in the basic form dictated by requirements of efficient attainment of organizational purpose. Informal organization is expected to perturb behavior within the basic form.

WORKING CONCEPTS AND DEFINITIONS

A necessary first step is to specify definitions of the firm and its objectives which are consistent with our task of building a design language. First, we shall distinguish between *logistic*, or productive activities, and *management*, or planning, implementation, and control activities.

Logistic Activities

Logistic activities are carried out within the firm to convert physical and information resources into the end products or services the firm sells to its customers. Logistic units in the organizations we seek to design may be departments, divisions, functional branches, such as production, R & D laboratory, or sales, or a firm as a whole. The complete list of generic resource conversion steps contains :

R & D (which generates an output of ideas for new or improved products and processes)
Purchasing
Personnel Hiring } (acquisition of input resources)
Financing
Manufacturing (conversion of input resource and ideas into output products)
Marketing (pricing, promotion, and selling activities)
Distribution (transferring products to locations from which they are available for purchase by and delivery to customers)

While these generic steps in the logistic process typically are applicable to a manufacturing firm, they can be generalized with varying degrees of emphasis to other entreprises, including insurance companies, hotels, or department stores. Appropriately translated and interpreted, the concepts also can be used to describe logistic activities in other types of organizations, such as hospitals, schools, or government agencies.

At some level within each organization, logistic process steps are grouped into categories such as those listed above. Within each group, there is further specialization of tasks, such as the distinctions between basic research, product development, and customer applications engineering groups in an industrial research laboratory. For our purposes, however, we shall subdivide logistic activities only to the level of the major functional areas of R & D, manufacturing, and marketing in our example of the business firm.

Management Activities

Management activities are the guidance and control processes of the organization. We shall structure these activities along two dimensions :

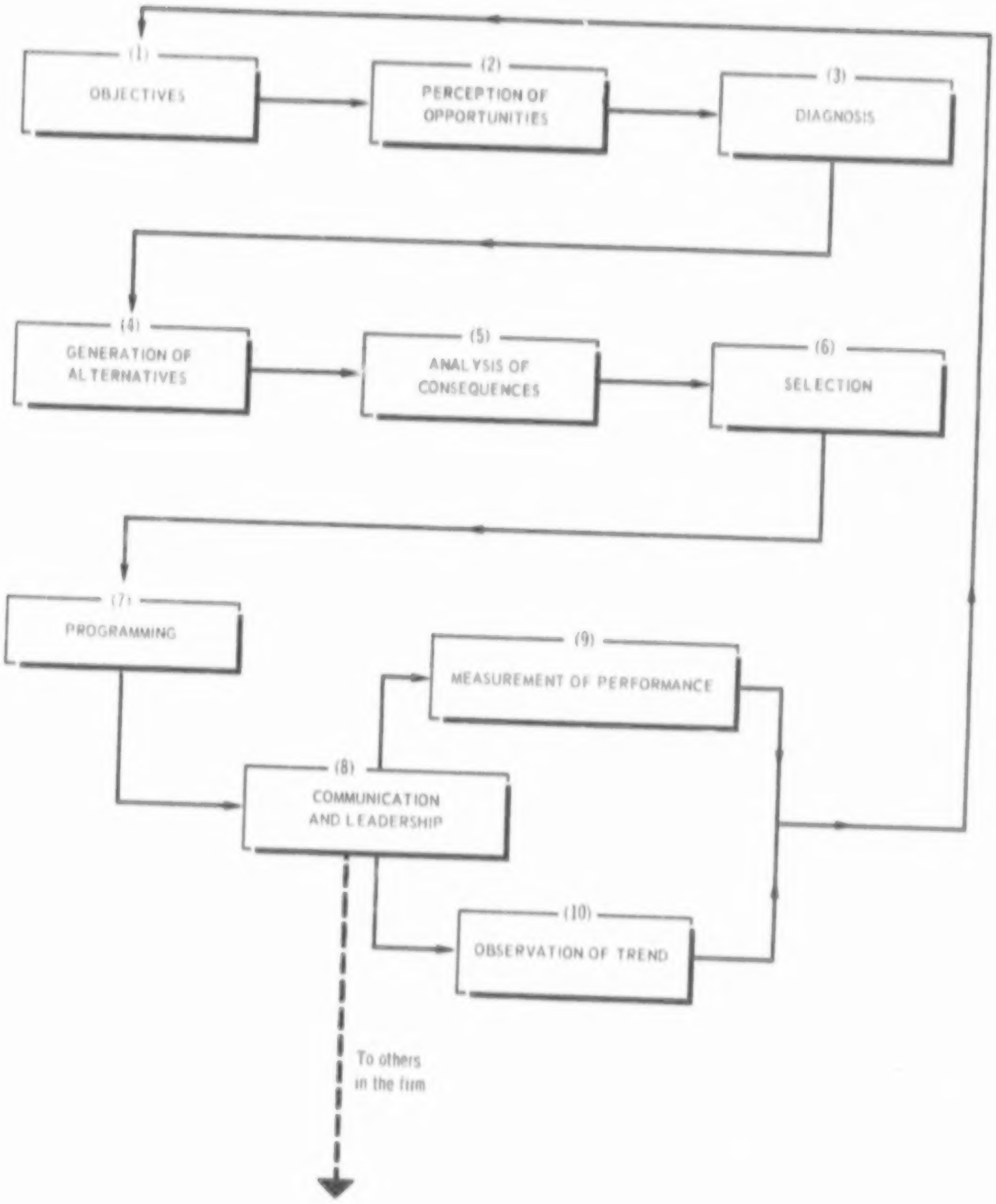
a. Types of problems which must be solved by managers ;
b. Problem solving process used by managers.

The first type of problem faced by business managers is choosing the products, or services to make, and the customers and markets to which to sell them. This selection of what the organization's " output vector " should be is called the ***strategic problem***. Second, management has to organize the firm by assigning decision-making authority and responsibility among participants, establishing work flows, laying out facilities, and setting-up information and reporting systems. These requirements for grouping, configuring, and establishing relationships among logistic and management activities are called *administrative problems* of management. Third, managers must schedule manufacturing operations, set pricing policies, carry out advertising programs, undertake research projects, collect accounts receivable, etc., in order to generate the desired output vector, using the established administrative relationships. Carrying out these activities in the most efficient manner possible poses *operating problems* for managers.

To solve strategic administrative and operating problems, managers use a process wich can be separated into eleven distinct steps as shown in Figure 1:

1. *Setting of objectives* for an organizational activity.
2. *Perception of problems and opportunities,* including both present and future deviation from objectives, and present and future prospects for improving the objectives.
3. *Diagnosis of problems and opportunities,* including what they are, their causes, and their effect on the organization.
4. *Generation of alternative courses of action* for solving the problem or exploiting the opportunity.
5. *Analysis of probable consequences* of each course of action.
6. *Action decisions* – Selection by management of preferred course of action.
7. *Programming* -- Translation of what should be done into how to do it – schedules, budgets, assignments of tasks to people.
8. *Communication and leadership* – Transmitting the program to organizational participants involved, insuring that they understand it, and motivating them so as to cause desired organizational action to take place.

Fig. 1. MANAGEMENT CYCLE


(1)
OBJECTIVES
(2)
PERCEPTION OF OPPORTUNITIES
(3)
DIAGNOSIS
(4)
GENERATION OF ALTERNATIVES
(5)
ANALYSIS OF CONSEQUENCES
(6)
SELECTION
(7)
PROGRAMMING
(9)
MEASUREMENT OF PERFORMANCE
(8)
COMMUNICATION AND LEADERSHIP
(10)
OBSERVATION OF TREND
To others in the firm

9. *Measurement of performance* and forecasting of expected output, in relation to objectives.
10. *Assessment of trends* and significant changes, both inside and outside the organization.
11. *Recycling* of some or all of steps 1 through 10.

Taken together, the three classes of problems and the eleven-step problem-solving process give a complete definition of *management* (1). Different decisions in different companies will, however, require differing amounts of management effort among the eleven steps. In some cases, steps will be carried out informally by a single manager or by face-to-face interaction among managers. In others, formal guidelines and relationships for carrying out the process will be set up, in recognition of the benefits from employing group processes and explicit analytical techniques for decisions of great complexity and consequence to organizational performance.

Three major patterns of relationships among steps in the management problem-solving process have evolved in business practice. The first, *implementation subcycle,* recycles steps 8 and 9 under conditions when the nature and content of organizational activity remains unchanged. The second, *control subcycle,* uses steps 1, 2, 3, and 9 to monitor, evaluate, and take corrective action on present performance to insure compliance with existing objectives. The third, and most complex pattern, is the *planning subcycle.* Extrapolative planning employs steps 1, 2, 3, 7, and 10 to make decisions based on forecasting information and objectives obtained from extrapolation of past performance of the firm. Entrepreneurial planning uses steps 1, 2, 3, 4, 5, 6, 7, and 10 to make decisions when step 9 indicates that the future will not be an extrapolation of the past or when the manager wants to depart from the momentum of existing operations. Here, objectives are thoroughly reappraised and a wide-ranging search for new action alternatives is conducted. (For a detailed discussion of extrapolative and entrepreneurial planning contexts, see (2)).

For this paper, we shall describe management in terms of three categories of problems (strategic; administrative; operating) and three types of problem-solving processes which can apply to each category (implementation; control; planning). Therefore, we shall be concerned with designing *line management* activities. In a later paper, we shall elaborate further on the relationships among

(1) Ansoff, H. Igor and R. G. Brandenburg, "The General Manager of the Future," *California Management Review,* Spring 1969 (forthcoming).

(2) Ansoff, H. Igor, *The Evolution of Corporate Planning*, Stanford Research Institute, Long Range Planning Service, Report No. 329, Menlo Park, California, September 1967.

the eleven generic steps of management-problem-solving, in terms of when and how specialists should be used to support each step as a formal information processing activity. This later paper will add a *staff* dimension to the management system of the organization.

OBJECTIVES OF ORGANIZATIONAL DESIGN

As we have seen above, attainment of organizational purpose depends on three major elements : the strategy selected, the structure constructed, and the manner in which the structure is operated. Each of these managerial choices contributes importantly to the success of the firm. The respective choices are interdependent. For example, a conglomerate product-market strategy in a business firm is usually accompanied by a type of organization structure resembling a holding company. In turn, the operations, actions, and decisions at the firm's headquarters follow a pattern typical of a holding company.

In this paper, we shall take the firm's strategy as given and shall assume that the operating style will be adjusted to the organizational structure. Thus, our problem can be stated as follows : given organizational objectives and its strategy, to design a structure which will offer the maximum performance potential for achieving the objectives.

As the objective of the organization, we choose maximization of return to the organization (from disposal of its products and services) on the resources employed in the organization. We make no assumptions on how this return is to be distributed among various interested parties. We do, however, assume that the interests of all of these parties are best served by maximizing the efficiency of the organization. The concept of maximum efficiency is difficult to make operational in practice, largely because of difficulties of prediction over long-term horizons (1). Therefore, we shall use three approximations :

1. An objective of maximizing near term performance (up to a *planning horizon)*.

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(1) Ansoff, H. Igor, *Corporate Strategy,* (Chapter 4), McGraw-Hill, New York, 1965.

2. An objective of long term growth which will develop a posture for successful long term performance (attained, for example, by acquiring a long-lived source of raw materials, such as timber, or by doing basic research).
3. An objective of protecting the firm against catastrophic risks, such as sudden obsolescence of its technology (attained, for example, by basing the firm's position on several technologies – the maxim of keeping one's eggs in several baskets).

If our understanding of organizational design were much greater than it is at present – in particular, if we knew how to construct analytic models of organizations – the three objectives of the organization could be used also as criteria of organizational design. Alternative designs could be modeled, the outcome to the firm predicted for each, and the design which contributes most to the objectives would be selected.

CRITERIA OF ORGANIZATIONAL EFFECTIVENESS

At the present stage of our understanding, we are forced to use second order *criteria* which permit a more direct evaluation of quality of organizational design. We group these criteria into four categories of organizational attributes. The first is *steady-state efficiency* which measures efficiency when the levels of throughput and the nature of throughput (the products made and the customers) remain relatively stable over time.

Table I lists a number of specific criteria. It is seen that steady-state efficiency is heavily dependent on the configuration of the elements of the logistic system. The optimal structure is one which would produce a specified level of throughput at least cost. It is attained through a compromise of advantages of scale, gained by geographic concentration of productive facilities, with the advantages of local costs mediated by the costs of transportation of goods from plants to the markets.

This particular aspect of the design of the logistic system is amenable to quantitative analysis. When steady-state effectiveness is the major criterion in organizational design, such analysis can frequently be made to yield the optimum structure.

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On the management subsystem side, the major problem is distribution of decision responsibilities among the several management levels. When conditions are steady-state, the criterion is to place the responsibility at a level at which all of the important conflicting variables are clearly visible and can be balanced. Thus, for example, pricing decisions would be made at the level above manufacturing, marketing, and R & D managers, because each of the former makes an important contribution to the overall decision. If applied to the extreme, this criterion would result in an overload in top management or would produce top-heavy management structure. There is therefore a need to decentralize the decision process. The corresponding decentralization criterion requires that decision responsibilities be so divided that each manager will optimize the performance of the firm when he seeks to make optimum decisions in his own area of responsibility (1).

Under steady-state there is a relatively low premium on speed of response to external or internal conditions. It is possible, therefore, to keep the management lean with just enough capacity to handle the decision load. A ratio which is frequently used to measure the " leanness " is the ratio of direct to indirect personnel.

The second major criterion is *operating responsiveness* which measures the abilities of an organization to make quick and efficient changes in the levels of throughput. This may be necessitated by changes in level of demand or competitive actions, such as, for example, a price reduction by competition, a drop in the firm's market share, or the unanticipated success of a new product.

As Table I indicates, the desired characteristics of the logistic system tend to be antithetical to conditions of steady-state efficiency. For example, they put a premium on local facilities in distinction to consolidated ones ; on standby as opposed to minimal capacity, etc. The management system needs to be similarly responsive. This requires continuous up to date information about the firm and the competition, and clear, rapid decision making. In distinction to steady-state, there is a preference for localizing decisions to " where the action is " in order to assure fast response.

The third major criterion is *strategic responsiveness* which measures the firm's ability to respond to changes in the *nature* (rather than volume) of its throughput, such as, obsolescence of products, changes in product technology, emergence of international markets, opportunities to enter new lines of business, changes in legal and social constraints under which the organization is forced to operate. Firms typically respond to these by changing composition of their products and markets, acquisition of other firms, or divestment from parts of existing operations.

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(1) Sengupta, S.S. and R. L. Ackoff, op. cit.

Strategic responsiveness imposes difficult demands on an organizational structure. First, it must have a well developed mechanism for surveillance of the firm's external environment. Strategic changes are often difficult to anticipate as, for example, in the case of a technological breakthrough or a sudden change in government in a politically unstable country. Mere availability of environmental information is not by any means a guarantee of organizational response. There is much evidence of failure of organizations to respond in time to visible "writing on the wall." Thus, a second requirement of the firm's structure is to provide for a decision center (or centers) which will be responsive to the intelligence inputs.

Thirdly, mere recognition of threats and opportunities does not usually indicate the specific response for the firm. Specific strategic moves must be generated. This is a very difficult task ; first, because it involves creative activity and, secondly, because generation of strategic moves is not localized anywhere in the firm. It takes place in the logistic systems, particularly in the R & D and marketing departments. It also takes place at all management levels, particularly among managers in close contact with the firm's environment. As a result, the structure must provide stimuli for generation of ideas throughout the firm, for effective communication between the management and the logistic subsystems and for timely and unprejudiced evaluation of suggested alternatives.

Finally, the process of physical introduction of change within the logistic system runs contrary to steady-state efficiency. New products seldom become immediate replacements for the existing product line. The work of developing and introducing them is additional to the previous logistic activity. It is, further, disruptive to this activity. As a result, the logistic structure must provide for the harmonious, simultaneous operation of both innovative and steady-state activities.

Criteria for assessing the adequacy of strategic responsiveness of the structure are summarized in Table II.

Structural responsiveness, the fourth criterion, measures the capabilities of an organization to change itself. When a firm is deficient in any of the three types of functional response, the solution is to adjust the structure. If the ability to adjust is inherent in the very nature of the structure, adjustment will be quick and without undue loss of efficiency. If structural flexibility is lacking, costly and slow transition is indicated.

An additional stimulus to structural response comes from changes in the technology of both the management and logistic processes. For example, introduction of computerized decision analysis makes it possible to restructure the management system into a more efficient form, or automation of a manufacturing process makes possible a more economic grouping of the logistic activities. Thus, structural responsiveness must provide for quick reaction to changes in strategy and operations, as well as conditions on a continuing process of self-renewal.

As Table II indicates, this requires logistic system capacity for monitoring process technology of the firm, a basic structure which can be easily expanded, contracted, or changed, and assets which can be changed from one configuration to another. Thus, for example, general purpose buildings and machinery give the firm a greater structural responsiveness than specialized ones.

Since, in recent years, the management process has also become technologically intensive, it increasingly requires appropriate environmental monitoring. Provision of capabilities for structural change (for example in manufacturing research, process R & D, operations research, organization planning) is needed to enhance generation of new ideas and their evaluation. Both generation and acceptance of ideas are enhanced in an organization in which structural decision making is decentralized : people are allowed to " organize themselves. "

Feasibility Criteria

When the preceding four groups of criteria are fully met by an organizational configuration, the potential efficiency of the firm will be near optimum. However, except indirectly, the criteria do not make a provision for the human element. The underlying assumption in Tables I and II is that the necessary talent is available, that individuals will accept organizational positions assigned to them, that they will do so to the best of their ability. Another underlying assumption is that the necessary financial and physical resources are available to build the preferred organization structure.

If any of these assumptions are not valid, the organizational design will not be feasible and must be modified to accommodate the limitations. To this end, a series of additional feasibility criteria are needed :

1. *Economic feasibility* is measured by the availability of the money, men, and physical resources necessary to build and maintain the organization. In the long run, feasibility could be reduced to availability of enough money. However, in order to be effective, many organizational changes have to be carried out within a relatively short time span. Under such conditions, availability of skills, particularly managerial and technical ones, frequently becomes the limiting factor in structural change.

Table III presents a set of typical feasibility criteria. In an ongoing firm, economic feasibility is checked annually through the budgeting process. If new organizational structure can be specified in sufficient detail, the operating cost component of its feasibility can be checked by pro forma budgeting. However, this usually does not include start-up costs which are more difficult to estimate. Among these, costs of new facilities and personnel and estimation of borrowing power usually can be well approximated. The difficult and important component is the learning cost incurred in organizational start-up.

2. *Human resource feasibility* is measured by the match between available human resources and the requirements of the structure. As seen from Table III, this should measure not only availability of the needed numbers of people but also acceptability of specified jobs to individuals, as well as incentives in these jobs (1).

Since our concern with logistic design is only down to the level of functional grouping, the list of human resource feasibility criteria does not include requirements for *intra* functional design of logistic units, such as participation in decision making, of opportunities for personal self-realization on the job, individual incentives to innovate, effectiveness of interpersonal communication, etc. Instead, the criteria presented in Table III deal largely with availability of human resources and the compatibility of pay and incentive systems to labor markets.

On the management system side, availability of qualified managers, as well as their individual aspirations, are frequently a major constraint on organizational feasibility. This is expressed in the saying that " organizations are built around people." During a reorganization, managers of the firm have a deciding influence on the choice of the structure. In making this choice, they seek to perpetuate and increase their own prestige, power, and rewards and to minimize threats to themselves. This limitation on feasibility of a structure is reflected in the first four criteria in Table III. Application of these criteria will frequently require large enough modifications in an " ideal " structure to produce substantial loss of organizational efficiency.

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(1) Simon, H. A., " On the Concept of Organizational Goals, " *Administrative Science Quarterly,* Volume 9, June 1964, pp. 1-22.

A frequently observed approach to this problem is to program a gradual development of the organization to the " ideal " form. The " ideal " organization emerges as key individuals move or retire, as new positions are created, or as the firm expands and creates new managerial opportunities.

The last two criteria under Human Resources Feasibility in Table III are of great practical importance in structural design. A typical (and frequent) example of behavior conflict is found in firms in which a management group nominally charged with evaluation, control, and allocation of resources among lower operating levels is staffed part time by managers from these lower levels. The result is a conflict of interests between the welfare of the lower level organization for which they have line responsibility and the welfare of the organization as a whole for which they are responsible as members of the higher level committee.

A solution (which was first enunciated by DuPont in 1919 and General Motors in the 1920's (1), (2)) is to separate operating responsibilities from "policy making" ones and to staff the two levels with different people. However, in organizations in which management talent is limited, this may not be feasible. Instead, a different structure may become necessary.

Decision and Information Quality Criteria

The preceding groups of criteria deal with the specific characteristics which a design must have for a particular type of organizational responsiveness. However, common to all of them is a need for an efficient and economical information processing system. Different types of responsiveness place emphasis on different phases of the system (as has been indicated in Tables I and II), but the general characteristic will be common.

While the information system is of importance in all activities of the firm, it has special significance for design of the management subsystem. Growth in size

(1) Chandler, A. D., Jr., ***Strategy and Structure,*** The M.I.T. Press, Cambridge, Massachusetts, 1962.

(2) Sloan, Alfred P., Jr., ***My Years With General Motors,*** Garden City, New York, Doubleday and Company, Inc., 1964.

and complexity of firms has long since created many pockets of specialized information and technical expertise throughout the firm (1). The introduction of management science and computers has added pockets of problem-solving expertise to those of technical expertise. As stated earlier, the net result is that decision-making, which is the substance of management, is increasingly becoming a group process.

This has added two important dimensions to the problem of organizational design. First, a complete design requires not only designation of the loci of management authority for decision and responsibility for action, but also assignment of the responsibilities for specific information processing tasks involved in arriving at a decision discussed earlier in the section on concepts and definitions. Second, to the specification of line management positions must be added specification of staff agencies which will perform these auxiliary tasks such as planning group, operations research group, forecasting group, etc.

The adequacy of these two new and related aspects of organizational design should be tested by an additional group of criteria which we shall call decision and information quality criteria. These are shown in Table IV.

With the advent of electronic computers, information has become potentially the most responsive resource in the logistic process. Its role in the logistic process should, therefore, be to aid (economically) in minimizing delays to the orderly progress of the process. This basic characteristic is elaborated in Table IV. Horizontal interfunctional exchange of information, both by formal and informal means, is a process of special importance, since it influences the effectiveness of transfer of resources between functions. Ineffective transfer has a two-fold undesirable consequence : it slows down the operating responsiveness of the firm, generates management problems, and thus adds to the decision workload.

The first seven criteria in the management subsystem are concerned with several aspects of defining the decision responsibilities of an individual manager in a way which produces the most effective result. This has been of concern to organizational designers for many years. Thus, in 1919, a report prepared in the DuPont Company stated :

> " The principle of individual responsibility and undivided authority has been recognized by the Company for many years... (managers) are

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(1) Galbraith, John Kenneth, *The New Industrial State,* Houghton Mifflin Company, Boston, Massachusetts, 1967.

> individually responsible for the conduct of that Company's business over which they have charge, subject only... to principles and methods laid down by authority next higher up... It is to the recognition of this principle that we may in large measure attribute the Compagny's phenomenally successful performance." (1)

Of crucial importance to the quality of decisions is the fact that they be made at a level at which all important interacting and conflicting decision variables can be taken into account. This tends to push decision responsibility up the managerial hierarchy. In conflict with this requirement are :
1) that decisions be made promptly , and 2) that they be made near the source of important information input. (This is particularly important in so-called ill-structured decisions in which information cannot be easily quantified ; therefore, much depends on the local manager's " feel " for the situation). Both of these requirements tend to push decision responsibility downward, near the place of logistic action. As we have seen in earlier discussions, this conflict is resolved differently for different types of performance responsiveness.

Whenever the decision is assigned, a related, but distinctive consideration, is that the manager be made fully accountable only for the performance he controls. This rule contributes much to organizational clarity and to motivation of individuals. This is closely related to the problem of measurement, for it is difficult to hold a manager accountable for actions whose value cannot be objectively assessed. Thus, an additional design criterion is to ensure that decision responsibilities are grouped in measurable " packages. "

The ideal form of accountability is to measure the manager's contribution to the overall efficiency of the organization. In the business firm, this gave rise to a wide acceptance of the concept of profit and loss accountability. Its application to date has been impeded by imperfections in today's business measurement systems : they can measure profit and loss contribution only at some levels of operation (typically, divisional levels, manufacturing, sales) but not in many others (R & D, financing, management training, advertising, etc.). However, it is safe to predict that, as measurement improves, the concept of profit and loss accountability (or marginal contribution to the overall organizational effectiveness) will be used throughout the organizational stucture.

Finally, assignment of decision-making responsibilities has to compromise the necessity to partition the total decision needs among managers, to avoid conflict of interests, and at the same time provide each manager with sufficiently wide scope of discretion for decision-making. Successful resolution of this compromise contributes to entrepreneurial behavior and to motivation of managers.

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(1) Chandler, A. D., Jr., Op. cit., p. 70.

The second group of criteria in Table IV deals with the process for making decisions, rather than assignment of responsibilities. As the individual criteria indicate, the concern is with quality and timeliness of information inputs, timely recognition of decision needs, quality of decision analysis, effectiveness of communication, and effectiveness of leadership in gaining decision acceptance.

BASIC ORGANIZATIONAL FORMS

One way to proceed about organizational design is through synthesis. Having identified general criteria, we could identify a particular sublist applicable to a given firm. Next, we could identify the basic dimension of the organization and then use the criteria to select and combine the dimensions into a desired organizational structure.

Another way to proceed is to identify several typical and basic organizational forms which are observed in practice. From these we can construct a larger list of observable special variations. The particular criteria can then be applied to this " library " of firms to identify the structure which most closely fits the firm. This form can then be further tailored to the unique needs of a firm with particular emphasis on economic and human resources feasibility.

We shall use the second approach because it is simpler and because it is possible to identify a number of what we shall call *basic forms* which have developed over the years in response to business requirements. With modification of terminology, the same process can be shown to apply to other purposive organizations.

At the first stage in the development, we shall construct a history of structures in terms of the following variables :

1. Levels of management responsibility and their relationships.

2. Type of decision assigned at each level : strategic, administrative, and operating. On occasion, we shall need to use the following subdivisions :

Strategic : S_e – expansion of present product-market position
S_d – diversification to new product-market positions.

Administrative : A_s – structure of the firm

A_r – acquisition and development of resources and capabilities.

3. On occasion, we shall need to subdivide responsibility for a particular type of decision into its respective components of planning, control, and implementation. We shall denote this by parentheses :

   E.g. S(P) – strategic planning
   A(I) – implementation of administrative decisions

4. Types of logistic function :

   financing, purchasing, manufacturing, R & D, etc. On occasion we shall use a subscript to distinguish among logistic activities devoted to :

   – throughput of current products , e.g., $(\text{mfg})_c$
   – maintenance and improvement of present capabilities , e.g., $(\text{R \& D})_i$
   – development of new capabilities , e.g., $(\text{Mkt})_n$

5. Grouping of both management and logistic functions by

   – capabilities of the function
   – products
   – markets
   – geographic location.

These dimensions will be adequate for description of gross authority-responsibility and work flow relations, or *L-L forms* (Line Responsibility-Logistic organization structures) developed in this paper.

The Centralized Functional Form

The first modern form evolved around the turn of this century in response to rapid growth in size and complexity of the business firm. It became known as the *centralized functional* (or *multi*-functional) organization and found widespread acceptance throughout American industry of the 1920's. It is still used widely both in this country and abroad.

The basic organizing principle is to group similar logistic activities under major functional managers who, in turn, report to a central headquarters (1).

The functional form is shown structurally in Figure 2 below, and its salient characteristics are summarized in Table V.

The principal advantage of the functional form is steady-state efficiency attained from economies of scale, overheads, and skills (we shall call the latter two *synergy*). (For a full discussion of the concept of synergy, see (2).) Economies of scale are generally proportional to the volumes of throughput for a particular product. On the other hand, economies of synergy will exist only if the skills, facilities process technologies, or managerial competence require similarity (3).

The functional form is also operationally responsive, thanks to a relatively simple communication and decision network. However, the responsiveness begins to drop off when either the size of the firm or the number of product-markets in the product line becomes large. Under either condition, both the management and logistic process begin to encounter a conflict of priorities, decisions and products begin to queue up, communication lines get longer, and time responsiveness to external conditions is degraded.

Strategic as well as structural responsiveness is inherently poor in the functional form. Since the same top management is responsible for operating, administrative, and strategic decisions, priorities have to be set up and attention allocated among the three. In the process, operating decisions tend to preempt the other two because of their large volume, ease of recognition, and immediacy of their needs (4). Strategic responsiveness is further impeded *within* the logistic functions by a conflict between steady-state and innovative activities. Since the functional form usually focuses on steady-state efficiency, innovative activities receive second priority (5). The problem is aggravated at points of transfer

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(1) In 1919, an Internal DuPont strategy stated the principle as follows:
"The most efficient results are obtained when we coordinate related effort and synegate to unrelated effort. For example, purchase of materials is unrelated to the size of a finished product in a much greater degree than manufacture and sales, or manufacturing and purchasing; and legal work is still more unrelated to either of those mentioned." See Chandler, op. cit., p. 69.

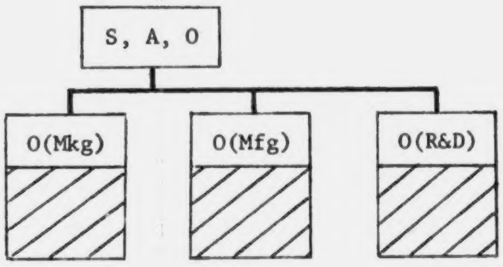
(2) Ansoff, H. Igor, ***Corporate Strategy,*** McGraw-Hill, New York, 1965.

(3) The economies of scale can be measured by reductions in unit cost of the product as the volume is increased, economies of synergy are measured by the difference between total cost of a combined product line and the sum of the costs of the same products produced by independent facilities.

(4) Ansoff, H. Igor, *Corporate Strategy,* Chapter 1.

(5) For example, pay and incentive systems are typically designed to reward current profitability rather than risk taking for future profits.

Figure 2


S, A, O
O(Mkg)
O(Mfg)
O(R&D)

Note: Shaded boxes denote logistic activities; clear boxes are identified by decision responsibilities assigned to them.

between two functions (for example, from R & D to manufacturing). Since for innovative activities transfer conditions are difficult to define, and since corresponding functions frequently have conflicting interests, the transfer process is slow and requires considerable management attention.

Structural responsiveness is impeded by lack of special organizational resources concerned with the generation and introduction of structural change.

However, with all its shortcoming, the functional form is both a historical milestone and an effective organizational form for certain firms. These are firms in operationally and strategically stable environments, with a limited number of similar products in the product line.

The Decentralized Divisional Form

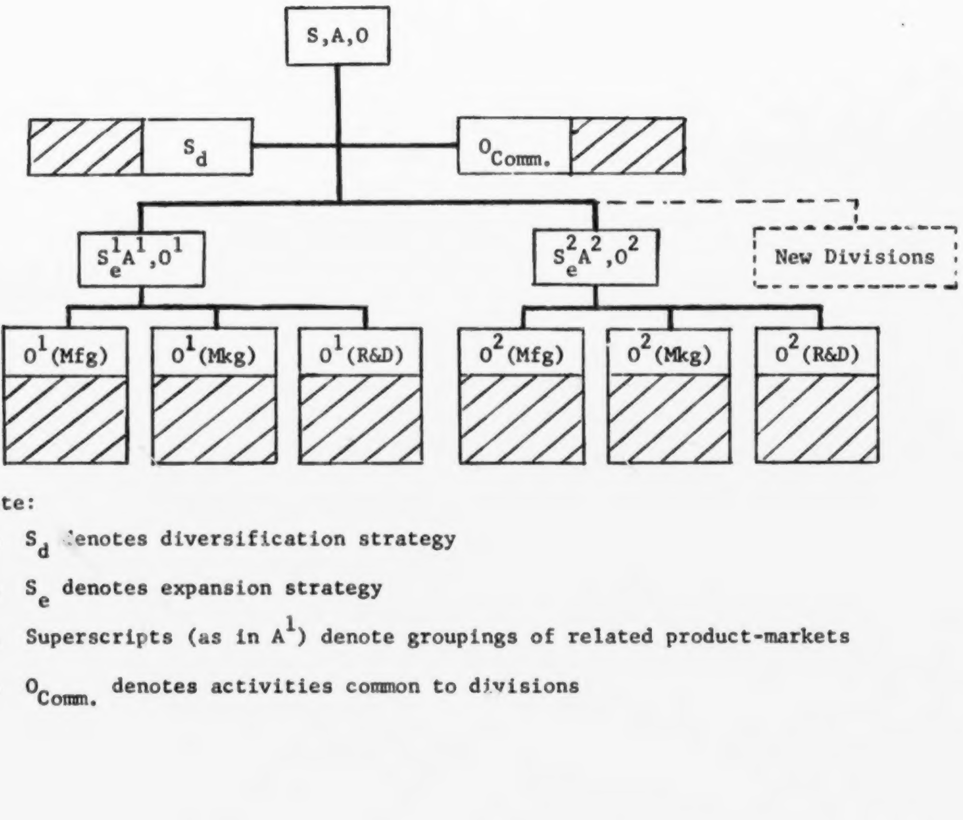
Development of the second basic organizational form was pioneered by DuPont and General Motors Corporation in the 1920's. The form received relatively slow acceptance prior to World War II but spread rapidly after the war to become the standard form used by a majority of the free world's large and medium sized corporations (1). It is known as *decentralized divisional* (or multi-divisional) organization. It characteristics are summarized in Table V and the structure shown in Figure 3.

The decentralized divisional form evolved as a response to the shortcomings of the functional form discussed above. Both General Motors and DuPont had grown to large size and both multiplied their products to a point where operational responsiveness was not adequate to the demands of their markets. In the case of DuPont, diversification had created a heterogeneous product family which put limits on realizable advantages of scale and, at times, produced *negative* synergy : managers were making production, manufacturing, and development decisions over a range of distinctive products, many of which lay outside the manager's competence ; standard logistic procedures which were optimal for some products were suboptimal for others.

The basic principle of the decentralized divisional form is to group activities by related product-markets and not by related logistic activities as is done in the functional form. Each group of product-markets (a division) is assigned to a manager who has complete responsibility for strategic, administrative, and operating decisions in the area assigned to him.

(1) However, as we shall see later, there is a number of significant variations on this basic form.

Figure 3. Decentralized Divisional Form



S,A,O
S_d
$O_{Comm.}$
$S_e^1A^1,O^1$
$S_e^2A^2,O^2$
New Divisions
O^1(Mfg)
O^1(Mkg)
O^1(R&D)
O^2(Mfg)
O^2(Mkg)
O^2(R&D)

Note:

1. S_d denotes diversification strategy
2. S_e denotes expansion strategy
3. Superscripts (as in A^1) denote groupings of related product-markets
4. $O_{Comm.}$ denotes activities common to divisions

In terms of strategy, this usually limits the divisional manager's scope to strategic expansion (S_e) of the present position. The responsibility for diversification (S_d) is reserved for the corporation. The corporation may assign implementation of diversification to a division or it may establish the required logistic activity at the corporate level as shown in Figure 3 by the shaded rectangle. In the majority of cases, this activity is focused on acquisition of other firms. However, in some firms, which are both technologically and diversification intensive, the corporate strategic activity develops a full range of logistic capabilities (again DuPont was one of the early pioneers in this area).

On the whole, the assignment of both management and logistic responsibilities for strategy is difficult and complex in a multi-divisional firm. In practice, this frequently results in lack of clarity of responsibilities and, consequently, poor management of strategic change.

In addition to diversification, it is common in multi-divisional firms to attach to the corporate office certain other logistic functions; such as purchasing, legal, financing, management training, and basic research. To qualify for this position, a logistic function should: (a) be common to more than one division, (b) offer advantages of scale on a multi-divisional basis, and (c) not degrade the efficiency of the respective divisions. In practice, criterion (c) is very difficult to measure, particularly since divisions find themselves competing for the services of the common function. As a result, the proper assignment of the common logistic functions becomes a bone of continued contention between divisional and corporate management. (The difficulty of resolving this contention for the purchasing function in the early days at DuPont has been clearly illustrated by Chandler (1)).

The major purpose of the divisional form was to preserve the operating responsiveness of firms which had grown large and complex. To the extent that this could be accomplished by subdividing the firm into divisions which had no common capabilities, an increase in operating responsiveness could be gained without loss of synergy or economies of scale. However, when a homogeneous product-market group had to be subdivided, economies of scale and synergies had to be sacrificed (2).

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(1) Chandler A. D., Jr., op. cit., Chapter 2.

(2) Such subdivision was made in General Motors and, subsequently, throughout the automotive industry. The loss of economies of scale between models has been sought through enforced interchangeability of parts among divisions, and loss of synergy was remedied by creating large common logistic organizations (such as styling) at the corporate level. The negative effect of this was loss of important elements of control over the product by divisional managers.

One important variant of such subdivision occurred in firms (such as petroleum companies) whose operations were widely dispersed geographically and whose operating responsiveness was dependent on delegation of responsibility to local managers (who could respond quickly and who were attuned to special local conditions). In such firms, divisions were grouped by geographical regions and all divisions had similar, if not identical, products.

The strategic and structural responsiveness of the divisional structure is, on the whole, superior to that of the functionally organized firm of comparable size. The smaller individual area of responsibility of each divisional manager permits him relatively greater attention to strategic questions than is possible at the headquarters of the functionally structured firm. On the other hand, the probable centralization of basic research forces him to compete with other divisions for research effort.

At the corporate level, the management workload is somewhat lighter than in a comparable functional firm. Strategic expansion decisions are delegated, and operating decisions are limited to monitoring divisional performance and approval of divisional plans. Thus, in principle, there is greater opportunity to consider diversification, overall strategy, and overall structure. In practice, corporate managements frequently fail to take advantage of these opportunities. They either continue to be over-responsive to operating problems or reduce the size of the corporate office to a minimum level at which no capacity exists for strategic and structural decision making.

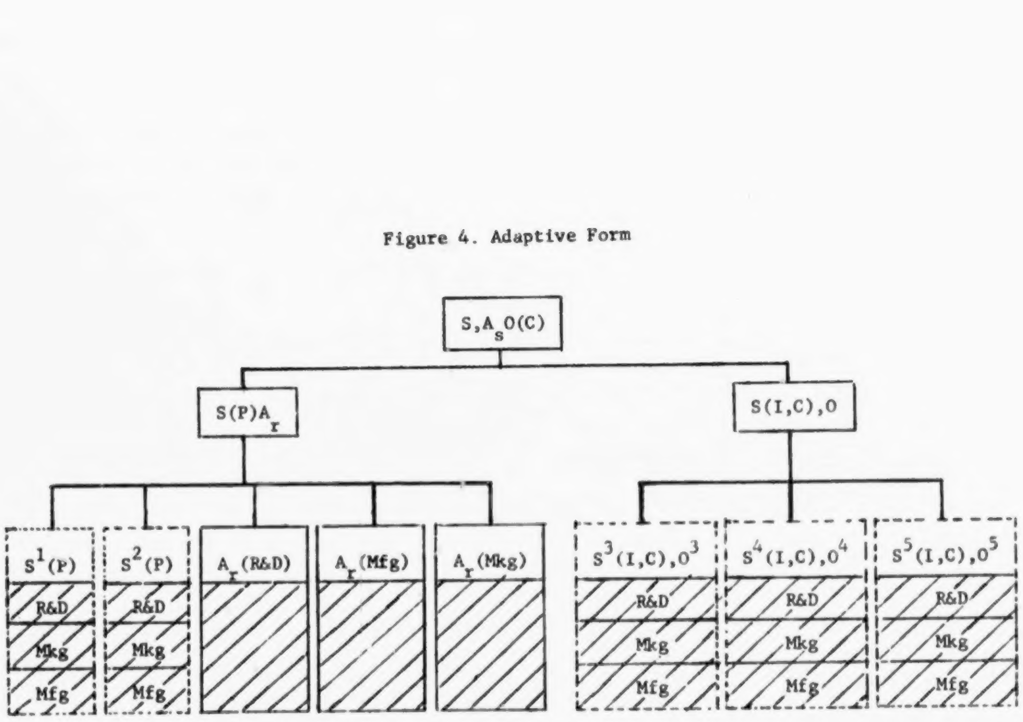
Unless the firm establishes a large corporate logistic activity for innovation of new products and markets, the logistic capability for innovation of the divisional form is subject to much the same problems as the functional form.

On the whole, the multi-divisional form was an important step in development of efficient structures. Its superiority over the functional form is that it combines steady-state efficiency with organizational responsiveness. However, it represents only a limited improvement in strategic and structural responsiveness.

Adaptive (Project Management) Form

The next basic form received recognition in the post World War II period. It evolved in answer to the need for structural responsiveness in firms whose product mix changed frequently, whose products were relatively short-lived, and which had to be both strategically and operationally responsive. Major users of this form have been technologically intensive defense firms in the United

Figure 4. Adaptive Form


S,A_s O(C)
S(P)A_r
S(I,C),O
S^1(P)
S^2(P)
A_r(R&D)
A_r(Mfg)
A_r(Mkg)
S^3(I,C),O^3
S^4(I,C),O^4
S^5(I,C),O^5
R&D
Mkg
Mfg

Legend: Superscript denotes distinctive product-market
Solid lines enclose permanent activities
Dotted lines enclosed temporary activities
S(P) - strategic planning responsibility
S(I,C) - strategic implementation and control
A_s - structural decision responsibility
A_r - resource and skills decision responsibility

States. It is illustrated in Figure 4 and described in Table VI. It is frequently called the Project Management Form, sometimes the Matrix Form. We shall name it the *Adaptive Form*.

In the adaptive form, the firm's activities are arranged into two groups : 1) a *development* group (left part of Figure 4) which is responsible for strategic planning, as well as for development and maintenance of the resources and skills of the firm ; and 2) a *project* group which is responsible for implementing strategic plans, as well as for operating the resulting product-market positions.

The structure is fluid and flexible. The permanent parts are the corporate office and offices of the manager of development, the manager of projects, and the functional managers. The managers of projects are appointed as new markets are entered ; they return to the functional areas of their specialties when the projects are terminated. The logistic resources and personnel are similarly rotated in and out of the functional competence groups.

Within the development group, temporary project planning teams may be formed drawing on management and logistic competences in the functional groups. Projects are initiated and planned within the competence group either by the *ad-hoc* teams or intra-functionally. Upon corporate approval, implementation of strategy and operations are transferred to the project group.

The functional managers in the development group recruit personnel, develop organizational capabilities, and concern themselves with innovating in process and management technology of the firm.

The corporate body concerns itself with corporate overall strategic planning (as opposed to specific project planning in the competence group), development of the organizational structure, approval and control of administrative plans of the development group, strategic plans of the development group, and operating plans of the project group.

The advantage of the adaptive form is its all-round responsiveness : strategic, structural, and operating. It is structurally responsive because the organization is open-ended and can quickly change form and shape. Acceptance of change is enhanced by the non-permanent assignments of both key managerial and logistic personnel coupled with job security and promise of new challenging assignments.

Operating responsiveness and rapid and effective implementation of strategy are assured by the focused concern of project managers on specific product-markets, as well as by exclusive dedication of logistic activities. Effective planning of strategy is made possible by : 1) limited load of responsibility at the corporate office, 2) dedication of the development group to planning and innovation, and 3) flexibility of project teams. Limited life-time of projects serves as a general incentive for concern with strategy and a deterrent to a preoccupation with operations.

The adaptive form also has two major limitations :

1. It produces minimal economies of scale and only limited synergy in the competence group. Since much duplication of capacities and capabilities results, steady-state efficiency is poor.
2. Successful application of the form depends on transferability of logistic resources among projects, and between projects and the competence group. The form clearly would not work for asset intensive industry such as chemicals, aluminum, automotive, etc. Nor would it be made to work whenever there is a serious difficulty in separating and assigning assets into separately controlled project packages.

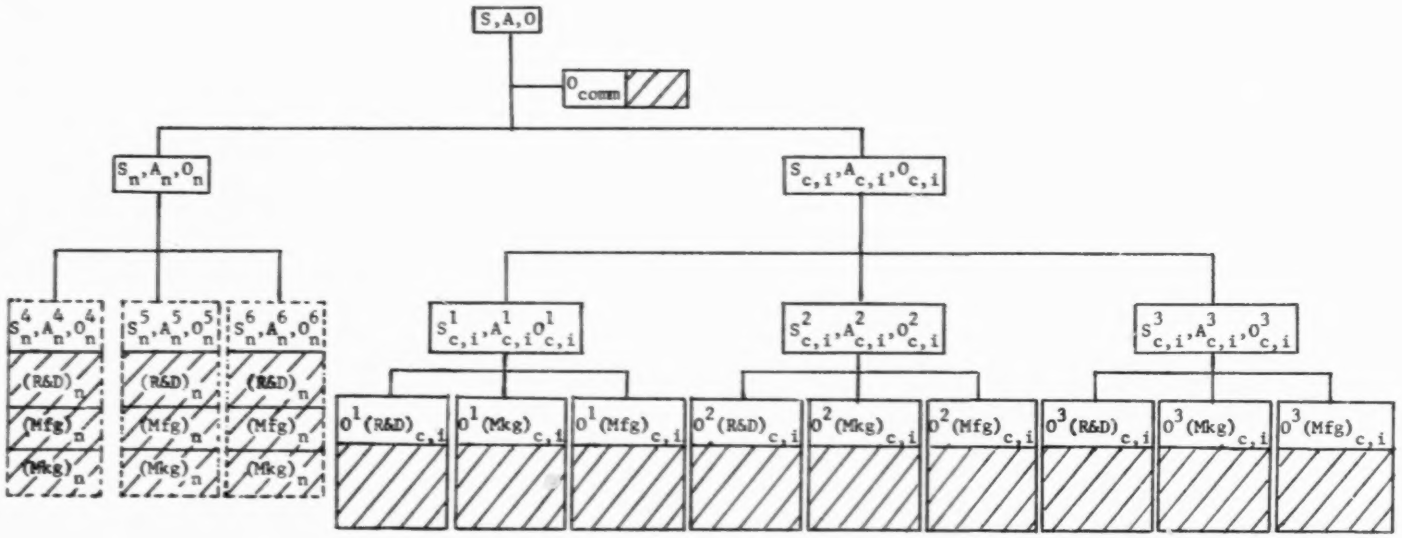
In its pure form, use of the adaptive form is limited to firms whose business is R & D intensive, whose production runs are limited, and whose operation is characterized by low or asset intensity, or flexible assets, or assets fully amortizable over the lifetime of individual projects.

The Innovative Form

This is the latest basic form to emerge from the continuing search by business firms which combines the virtues of all major performance criteria; steady-state efficiency, operational response, strategic response, and structural response. Before describing it, we need to make a distinction between creativity and innovation. The former is the activity of generating ideas of promising new strategic moves for the organization. The latter includes creativity but also encompasses the process of translation of the idea to a full marketable and potentially profitable product. A successful competence group in the adaptive form would be called creative in this sense of the two words. But, if there is no mechanism for taking project ideas to the market place, such a firm would probably have a very poor record as an innovator.

We could expect a competently run complete adaptive structure to be a successful innovator. However, as the preceding remarks indicate, the structure

Figure 5. The Innovative Form


S,A,O
O_{comm}
S_n,A_n,O_n
$S_{c,i},A_{c,i},O_{c,i}$
S_n^4,A_n^4,O_n^4
S_n^5,A_n^5,O_n^5
S_n^6,A_n^6,O_n^6
$(R\&D)_n$
$(Mfg)_n$
$(Mkg)_n$
$S_{c,i}^1,A_{c,i}^1,O_{c,i}^1$
$S_{c,i}^2,A_{c,i}^2,O_{c,i}^2$
$S_{c,i}^3,A_{c,i}^3,O_{c,i}^3$
$O^1(R\&D)_{c,i}$
$O^1(Mkg)_{c,i}$
$O^1(Mfg)_{c,i}$
$O^2(R\&D)_{c,i}$
$O^2(Mkg)_{c,i}$
$O^2(Mfg)_{c,i}$
$O^3(R\&D)_{c,i}$
$O^3(Mkg)_{c,i}$
$O^3(Mfg)_{c,i}$

is not applicable in a large majority of manufacturing firms in which economies of scale are important, assets and competences are relatively inflexible, and products have long lives. It is important for such firms to meet the conditions of steady-state efficiency. The *innovative form,* which is shown in Figure 5 and described in Table VI, is designed to meet this requirement. (For description of one application, see (1).)

The underlying principle is to gather currently profitable, established product-markets into a *current business group* and to place development of new product-market positions into an innovation group. The latter may include both diversification and expansion activities. (For a detailed description of the difference between strategic diversification and strategic expansion, see (2).) In this case, the strategic activity of the current group would be limited to exploitation of current position (such as increased market penetration) or incremental improvements in current products. Another possibility is to limit the innovation group to diversification activities and assign full strategic expansion responsibilities to the current business group. This allocation of strategic action responsibilities is a matter of considerable importance and difficulty. On the one hand, exclusive allocation of strategy to the innovation group would tend to get it out of touch with the current market opportunities but would offer synergies in performance of R & D. On the other hand, the allocation of a large measure of strategic responsibility to the current business group defeats the very purpose of the innovative form which is to provide strategic and structural responsiveness.

The innovative form operates as follows. New product-market entries are conceived, planned, and implemented by the innovation group on a project basis. The group remains responsible for the project until its commercial feasibility has been established. This means, for example, that pilot production facilities have been constructed and market tests undertaken. At the point of feasibility, the project is transferred into the current business group where it may become a part of an existing division or (if the product-market is distinctive and its potential high enough) forms the nucleus of a new division.

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(1) Ruffo, John J., *Making Corporate Innovation Inevitable,* presented to the Association for Corporate Growth, Inc., New York, September 13, 1967.

(2) Ansoff, H. Igor, " Vers Une Théorie Stratégique des Entreprises ", *Economies et Sociétés,* Tome II, No. 3, Mars 1968.

The transfer may include all the personnel and facilities or just the product and the technology. The former mode has considerable merit, because it exposes managers to operations in both the innovative and " steady-state " environment and provides a valuable exchange of information and experience. In some firms, such transfer is only temporary and the innovation-oriented people return to the innovative group after a tour of duty.

The current business group in the innovation form can be structured either divisionally or functionally depending on which of the two forms of organization is more appropriate to the established product-markets.

The innovative form potentially offers high responsiveness on all four of the major organizational performance criteria. However, some economies of scale are sacrificed both because of duplication of resources in the two groups and because of the project structure of the innovative group. The separation of innovation from current operations poses problems of communication of the new needs, opportunities, and trends perceived by salesmen in the current business group to the new project generators in the innovation group. Unless this communication is well developed, there is a danger that the innovators will tend to neglect expansion opportunities in favor of diversification.

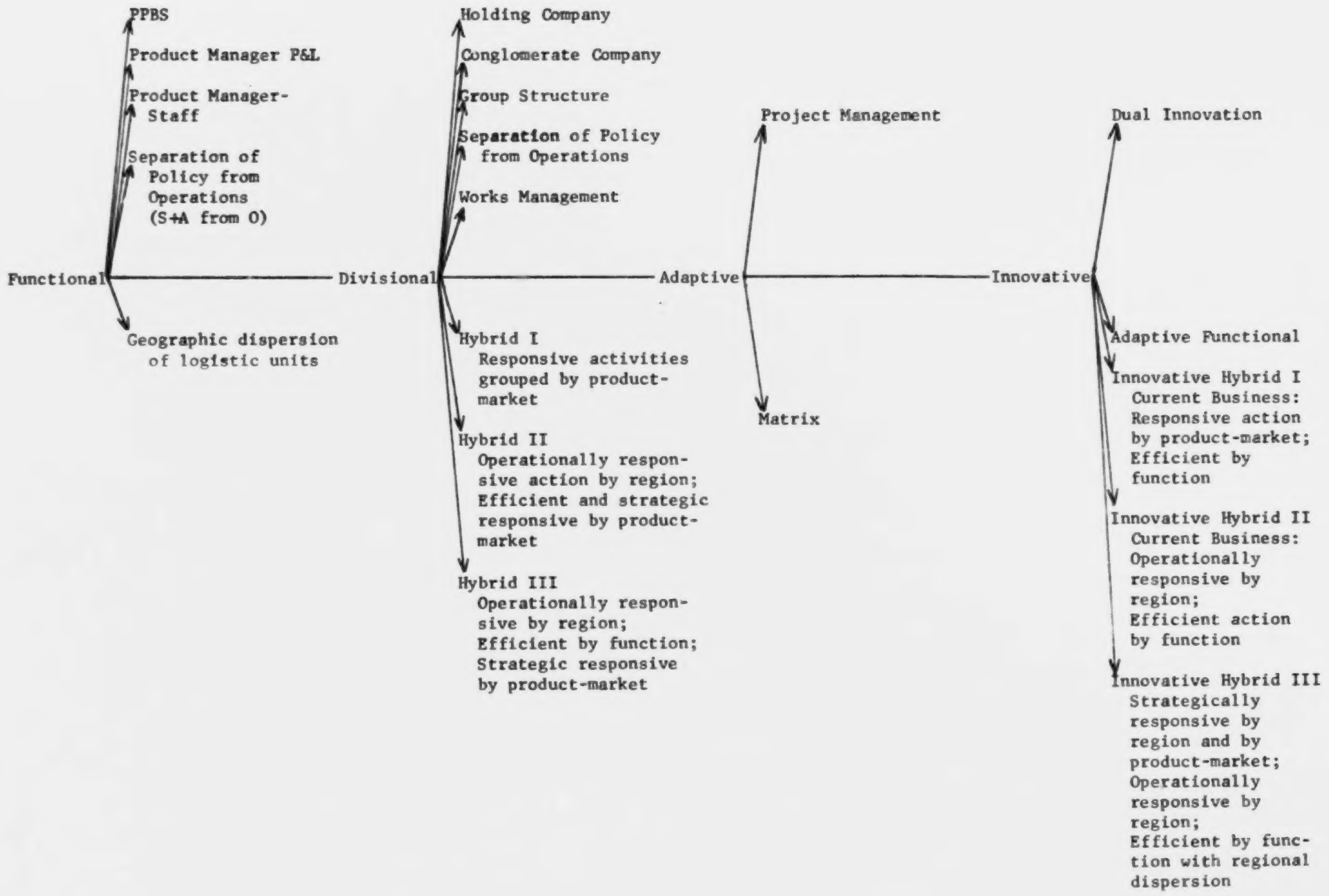
MODIFICATIONS TO BASIC FORM

None of the four basic forms is fully and equally responsive to the major organizational behavior criteria ; each is a compromise designed to fit a distinctive set of conditions. Therefore, in approaching the task of organizational design, each firm needs to select the set of design criteria (from the generic lists provided earlier in the paper) applicable to its particular business and environment. It can then apply these to the basic forms (using the tables provided in this paper) to select the form which most closely approximates its needs. In most cases, the basic form will fail to meet some special requirements unique to the firm. Therefore, further refinement of structure is necessary. This refinement is basically of two kinds : one is to combine more than one basic form in the same organization ; the other is to subdivide the decision-making responsibilities to assure appropriate decison priorities, or to distribute the workload, or to focus attention on a problem of particular importance to the firm.

Figure 6, entitled " Tree of Organizational Development, " shows the chronological sequence of the basic forms, together with a number of significant variations which have been observed in practice. Each is briefly described below together with conditions for its applicability.

Figure 6

TREE OF ORGANIZATIONAL DEVELOPMENT


Functional
PPBS
Product Manager P&L
Product Manager-Staff
Separation of Policy from Operations (S+A from O)
Geographic dispersion of logistic units
Divisional
Holding Company
Conglomerate Company
Group Structure
Separation of Policy from Operations
Works Management
Hybrid I Responsive activities grouped by product-market
Hybrid II Operationally responsive action by region; Efficient and strategic responsive by product-market
Hybrid III Operationally responsive by region; Efficient by function; Strategic responsive by product-market
Adaptive
Project Management
Matrix
Innovative
Dual Innovation
Adaptive Functional
Innovative Hybrid I Current Business: Responsive action by product-market; Efficient by function
Innovative Hybrid II Current Business: Operationally responsive by region; Efficient action by function
Innovative Hybrid III Strategically responsive by region and by product-market; Operationally responsive by region; Efficient by function with regional dispersion

Variations in the Functional Form

1. *Planning Programming Budgeting System (PPBS).* This was developed at the RAND Corporation and applied by Hitch and McNamara to the Department of Defense. It is currently being applied in a number of business firms.

Basically PPBS is a planning system which provides visibility to the firm's product-market potential, its strategy, and its performance in respective product-market environments (McNamara called them " missions ") in which the firm operates (1). In a functionally organized firm, PPBS provides top management with information about the nature and direction of the firm's business which cannot be directly inferred from analyzing the respective functions. Such visibility is useful if the firm's product markets are, in fact, addressed to several distinctive demand environments, if the environments are strongly competitive and, particularly, if they are subject to rapid strategic change. Under these conditions, PPBS can improve both operational and strategic responsiveness of the firm ; *but only at the planning level in the management subsystem,* since the functional logistic subsystem remains unchanged.

Structurally, introduction of PPBS requires the addition of a staff planning activity at the corporate level.

2. *Product Manager Organization.* The product manager structure is aimed at providing both operating and strategic responsiveness to individual products in a functional organization. It differs from PPBS, first, in its more narrow perspective on products of the firm and, second, in adding responsibility for various degrees of implementation and control in addition to planning. The two concepts are not contradictory and, in fact, complement each other.

In one extreme version of the concept, an individual manager is made accountable for the performance of a particular product. Accountability here means following implementation of plans, assessing the performance, and spotting and anticipating problems. The project manager is given no authority or direct responsibility for the success or failure of the product. He is primarily responsible for generating and communicating information on the particular product.

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(1) *Government Planning and Budgeting,* Stanford Research Institute, Long Range Planning Report 310, Menlo Park, California, 1967.

At the other extreme, a product manager can be made fully profit and loss responsible for a product. This gives him responsibility for all decisions pertaining to the product, but in a functional structure he has to " buy " his logistic resources to carry out the decisions. His mechanism for this may vary from an internal market mechanism in which he purchases services from others in the firm, or it may be a mechanism of persuasion by implied authority : failing to get satisfaction from functional managers, he can take his case to a higher level of authority, who is superior both to him and the functional managers.

Another variant of product management structure is to assign some logistic functions to the product manager (such as marketing) leaving him to obtain other logistic outputs from functional areas. The underlying rationale is that this arrangement makes it possible to combine operational responsiveness with steady-state efficiency.

3. *Separation of policy from operating responsibilities.* This modification, which applies equally to the divisional form, is intended to reduce the workload of individuals in the corporate office and also to provide a priority setting mechanism for attention to " policy " which, in our language, means the strategic and the administrative decisions. The titles of the president and executive vice-president are commonly used to designate the respective positions.

4. *Geographic dispersion of logistic units* which may be made necessary by transportation costs, or location of raw materials, or cultural and political barriers, does not basically change the structure of the functional form, but places severe communication burdens on the organization. When operational and/or strategic responsiveness are important to success, wide geographic dispersion may make advisable a shift to the divisional structure, even at the expense of economies of scale.

Variations in the Divisional Form

1. *Works Management* structure resembles the functional structure in that managers in control of logistic facilities are given only the authority for operating decisions, all the strategic and administrative decisions being reserved for the headquarters. Thus, while the works manager (in this structure) may have several functional areas reporting to him, he must refer all non-operating decisions to higher levels.

2. *Holding Company* lies at the other extreme from works management. Under this concept, the central management delegates all decision responsibilities to the divisions (or subsidiaries) retaining only financial control and certain common logistic functions, usually corporate financing, legal, and real estate.

3. *Conglomerate Company.* This is closely related and currently a very popular variant of the holding company. While performing the holding company functions, the corporate office places a major emphasis on diversification through acquisition of other firms and occasional divestment of divisions which do not meet the financial performance standards of the firm.

4. *Hybrid Forms.* The lower part of Figure 6 shows several derivatives of the divisional form which group the use oriented parts of the firm according to different principles in order to make them most responsive to a particular organizational performance criterion. For example, hybrid in a mass production competitive consumer industry would be represented by a firm which organizes its R & D and marketing on the divisional principle, and its manufacturing and distribution on the functional principle. In Hybrid II, marketing might be organized on a regional basis for all products of the firm, but R & D and manufacturing grouped by distinct product lines. Hybrid III is a triple one ; marketing might be regional ; manufacturing, functional ; and R & D, by major product line.

While hybrids provide a desired mix of organizational characteristics, they tend to create serious problems of international communications, planning, and control. A solution frequently used is to create an internal market place with various parts of the firm buying and selling from one another. Since the market is usually too small for fully competitive behavior, a difficult problem of setting transfer prices is created at top management levels.

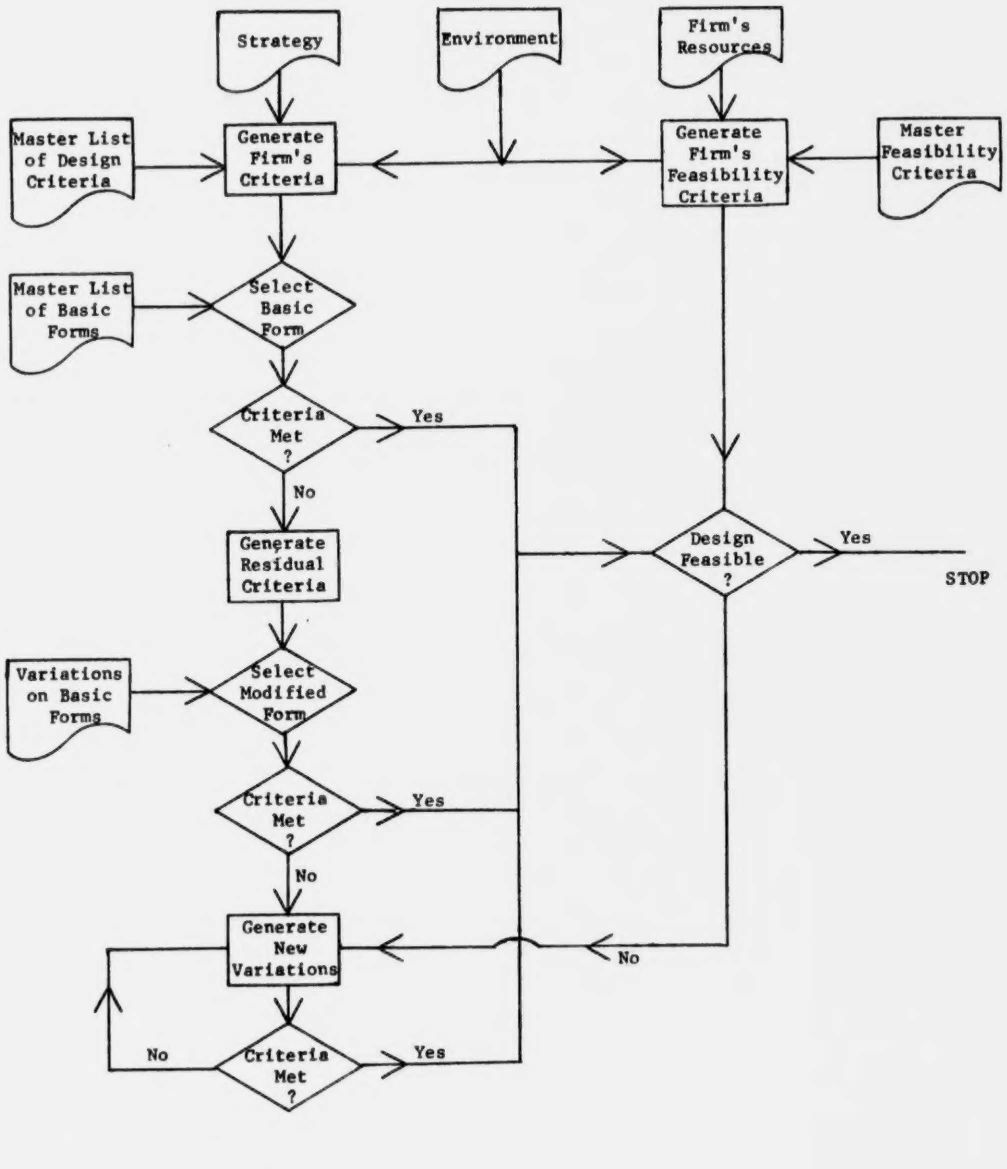
Variations on the Adaptive Form

1. *Matrix* organization is a name which has been used to describe a variant of the adaptive form in which the administrative part of the competence group is organized not according to normal logistic functions, but rather to distinctive skills and competences of the firm.

2. The *project management* structure resembles the divisional form, with project manager being equivalent to divisional manager. The distinction lies in the fact that the projects have finite life times and the project portfolio changes as completed projects are phased out and new ones are started.

Figure 7

PROCESS OF ORGANIZATION DESIGN


Strategy
Environment
Firm's Resources
Master List of Design Criteria
Generate Firm's Criteria
Generate Firm's Feasibility Criteria
Master Feasibility Criteria
Master List of Basic Forms
Select Basic Form
Criteria Met ?
Yes
No
Generate Residual Criteria
Design Feasible ?
Yes
STOP
Variations on Basic Forms
Select Modified Form
Criteria Met ?
Yes
No
Generate New Variations
No
No
Criteria Met ?
Yes

Variations on the Innovative Form

1. *Dual Innovation* is a form under which both the innovative group and the current business group are made responsible for strategic change. The former is assigned diversification, and the latter, expansion.

2. *Adaptive-functional* form organizes the current business group on a functional basis. This would be appropriate to an industry which is technologically intensive, but in which requirement for operational responsiveness is low, as compared to the importance of steady-state efficiency. A technological leader (such as DuPont was in the 30's through the 50's) with strong patent protection on its inventions, could successfully operate in this mode.

3. *Hybrid Forms:* Since the innovative form is the richest in structural possibilities, possible variations are correspondingly numerous. As mentioned above, each hybrid, while endowing a part of organization with particularly desirable characteristics, creates problems of internal interaction which are still very poorly understood. Hybrid I splits the current business group into functional and divisional-type activities. Hybrid II mixes regional and functional orientation. Hybrid III extends Hybrid II, first, by dispersing innovative activities geographically and then assigning specific (world-wide) product-market responsibilities to each. This closely resembles the structure which is emerging in technologically intensive, multi-national firms such as I.B.M.

THE PROCESS OF ORGANIZATIONAL DESIGN

The purpose of this paper is to develop a language for organizational design useful in selecting that form which leads to efficient attainment of organizational purpose. The design process employing this language is a heuristic method of matching the firm's organizational design criteria against commonly used organizational forms and progressively refining the selected form until a satisfactory closure is attained between criteria and characteristics of the organization. The overall process is summarized in Figure 7. Execution of many of the steps requires complex data-gathering and analysis activities. However, since our major concern here is with language specification, we shall outline the design process only in broadest terms rather than elaborate each step in detail.

Using the master list of design criteria, the strategy of the firm, and the characteristics of its environment, we can generate a list of specific design criteria for the firm in the order of their priority.

An application of this list to the characteristics of the basic forms (shown in Tables I, II, and III) can help narrow the choice to the most suitable form. A check is then made for the gaps between characteristics of the form and the needs of the firm. If the differences are judged not large enough to warrant further search, the selected design can be tested for feasibility. If the decision is to proceed, a list of criteria which still remain to be met is compiled and applied to the modified forms list (shown on Figure 6).

If the selected modified form is still inadequate, a creative process of generation of new interesting variations is called for. This process continues until a judgement is made either that criteria are now met or that it is not worthwhile to proceed further (which, in fact, amounts to lowering the criteria of organizational performance).

The feasibility check proceeds similarly through iteration until a form is found whose resource costs are within the means of the firm.

SUMMARY

In this paper, we have attempted to develop a practical language and an approach to selecting the organizational structure which best suits a particular efficiency-seeking organization. In this effort, we have taken a task-oriented view of the firm, approaching that used by organizational designers in business firms. Behavioral considerations are treated as constraining rather than primary variables. Our basic aim has been to develop a process for designing two closely coupled but different activities of the firm : its goods-producing logistic process, and the decision-producing management process. Our language consisted of primary logistic activities of the firm, the primary types of decisions, and principal processes by which the decisions are made and carried out. This language has enabled us to enrich the descriptions usually found in organizational charts and to sharpen both the content and the relationships among management roles.

Our focus has been on what we have called L-L (Line Responsibility - Logistic) language. We have recognized but not elaborated a much richer L-S-L (Line-Staff-Logistic) language which is needed to describe fully the many new and growing uses of formal information-processing assistance in support of both the management decision-making and the logistic flow of goods. Such description will be the subject of a later companion paper.

TABLE I

	Steady-State Efficiency	Operating Responsiveness
Logistic System	- Economies of scale - Economies of skills and overheads (Synergy) - Capacity matched to demand - Minimum logistic transportation costs - Logistic activities located in low cost labor and material areas - Logistic activities are located where source resources are available	- Short transfer times among logistic activities - Communication among logistic functions - Standby logistic capacity - Standby information processing capacity - Availability of product at market locations - Balanced inventory
Management System	- Decisions located at levels where all important tradeoffs are visible - Decisions centralized at levels which permit coordination of related lower level activities - Decisions decentralized to levels at which local optimization leads to global optimization - Management capacity - minimum needed to meet demand (Minimum indirect to direct ratio of personnel) - Explicit (quantitative whenever possible) performance yardstick - Management by exception	- Internal management information system - Competitive information system - Decisions decentralized to action level - Decisions centralized to level required for introducing effective change in logistic throughput - Clear decision assignment - Clear decision priorities - Rapid decision response times - Standby decision capacity - Contingency plans for changes in throughput level

TABLE II

	Strategic Responsiveness	Structural Responsiveness
Logistic System	- Perception of product-market threats and opportunities - Internal generation of strategic moves (Product-market R & D) - External search for strategic moves - Effective communication of threats, opportunities, and new moves to management - Minimal conflict between steady-state and innovative activities within each function - Transfer of new products from function to function - Capacity adequate for innovation - Transferability of assets to new products and markets - Transferability of skills and capacities to new products and markets - Work environment conducive to innovation - Reward system for strategic innovation	- Monitoring of process technology - Generation of changes in process technology (R & D on process technology) - R & D on management technology - Expandable/contractable structure - Transformability of assets into new configurations - Work environment conducive to innovation - Flexible promotion system - Reward system for structural innovation - Formal personnel and management training and development system
Management System	- Strategic information system - Clear statement of objectives and priorities - Strategy formulation - Communication of strategy to logistic function - Evaluation of strategic moves - System for transfer of innovation from function to function - Clear strategy decision assignment - Management capacity for strategic change - Compensation system encouraging strategic innovation	- Monitoring of management technology - Open multi-channel management information system - Anticipation of need for change - Evaluation of proposed changes - Participative decision making in structural changes - Participation of logistic personnel in decisions to change logistic system - Decentralized decisions - Management capacity for structural change - Compensation system conducive to structural innovation - Flexible promotion system

TABLE III

	Economic Feasibility	Human Resource Feasibility
Logistic	- Availability of raw materials - Working capital acquisitions - Technology acquisition costs - Physical asset costs - Operating costs [direct / overhead] - Personnel recruiting costs - Training and organizational development costs - Timing of organizational buildup	- Availability of manpower in the firm - External market for manpower - Availability of required skills - Match of pay scales and benefits to market demands - Match of industrial relation policies to characteristics of labor market
Management	- Availability of financing - Management acquisition costs - Management system setup costs - Management training costs - Physical assets (Offices, Computers) - Management operating costs - Staff support costs	- Availability of management talent for new managerial roles - External market for managers - Match of prestige and power between present and new roles - Match of pay and incentives to position demands - Absence of behavioral conflict in position specifications - Areas of discretion for managers to exercise initiative and entrepreneurial talents

TABLE IV

	Decision and Information Quality
Logistic Subsystem	- Interfunctional communications [formal informal - Timeliness of information - Availability of relevant information - Absence of irrelevant information - Economies of scale in data generation, processing, distribution
Management Subsystem a) Specification of decision responsibilities	- Match between decision level and relevant information - Time delay in decision making - Compatibility of authority and accountability - Decisions located at points where all relevant tradeoffs are visible - Clarity of decision assignments
b) Quality decision making system	- Visibility of key decisions - Forecasting and environmental surveilance - Measurement of performance and capabilities - Communication to decision makers (timeliness, relevance) - Timeliness of recognition of decision needs - Quality of decision analysis [formal informal - Match of intensity of analysis to importance of decisions - Communication to logistic process - Lateral communication among cooperating managers [formal informal - Exercise of leadership in acceptance of decisions - Exercise of leadership in implementation

TABLE V
Basic Organizational Forms

TYPE	ORGANIZING PRINCIPLE		APPLICABILITY		
	Management	Logistics	Efficiency	Conditions	Shortcomings
Functional	1. S + A + O Concentrated at corporate office	1. Like activities grouped	1. Steady-state economies of scale 2. Operationally responsive for limited product-market area	1. Stable environment 2. Small size 3. Single product-market firm	1. Slow strategy structure response 2. Top management overload in large firms 3. Top management priority conflict in multi-product firms 4. Loss of operational response in multi-product firms 5. Slow logistic response to innovation
Divisional	1. Group by product-market areas 2. Divisional P & L (S,A,O) responsibility by product-market area 3. Corporate responsibility for overall S,A,O 4. Corporate responsibility for common logistic functions	1. Duplicate most functions for each product-market area 2. Group some common functions	1. Operationally responsive for broad product-market area 2. Economies of scale in common functions 3. Strategically responsive for product improvement and market expansion	1. Operationally responsive in dynamic environment 2. Distributes top management load in large size firm 3. Resolves priority problem in multi-product-market firm 4. Geographically diversified divisions	1. Slow structural response 2. Poor response for product-market diversification by divisions 3. Acquires shortcomings of functional form as each division gets large 4. As number of divisions gets large, corporate office becomes overloaded - tends to holding firm 5. Loss of efficiency in firms with widely separated markets for respective product lines 6. Suboptimal efficiency by logistic function due to conflict of innovative and steady-state actions

TABLE VI
Basic Organizational Forms

TYPE	ORGANIZING PRINCIPLE		APPLICABILITY		
	Management	Logistic	Efficiency	Conditions	Shortcomings
Adaptive	1. Competence group responsibility for A_r resource acquisition and capability maintenance 2. Competence group responsible for strategic project planning $S^i(P)$ 3. Project group responsible for implementation and control of projects $S^i(I,C)$ 4. Projects group responsible for O^i operation of projects 5. Overall strategy S and A_s (Structure) at corporate level	1. Group by functions in competence group 2. Group by product-market in project group 3. Project duration limited by life-cycle 4. Free transfer of logistic resources between compentence and project groups	1. Strategically responsive 2. Structurally responsive 3. Operationally responsive	1. Strategically dynamic environment 2. Limited duration of projects 3. Advantages of scale not important 4. Technologically intensive business 5. Marketing intensive business 6. Operationally dynamic environment 7. Structurally dynamic environment 8. Number of distinct projects limited	1. Minimal economies of scale 2. Degraded strategic response in multi-project firms - top management overloaded 3. Concept does not apply when assets are either: (i) non-transferable from project to project or (ii) non-separable into project packages
Innovative	1. Innovation group (S,A,O) Profit & Loss responsibility until time of transfer 2. Innovation group structured as Profit and Loss responsible projects 3. Current business group has divisional or functional structure	1. Transfer of products from innovation to current group at end of "red ink phase"	1. Strategically responsive 2. Structurally responsive in innovative activities 3. Economies of scale and synergy in current business group 4. Operational responsiveness depends on current group's structure	1. Strategically dynamic environment 2. Large percentage of firm's budget in innovation 3. Technologically or marketing intensive business 4. Operationally dynamic environment 5. Advantages of scale important in current business	1. Loss of economies of scale between innovation and current groups 2. Costs and barriers in transfer to current group 3. Economies of scale minimal in innovative group (Synergy is a function of the product-market

THE ABORTING CORPORATE PLAN

A Cybernetic Account of the Interface between Planning and Action

by

Stafford BEER(1)

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(1) Stafford Beer, Development Director, The International Publishing Corporation, London.

1. PRELIMINARY PARADOX

Much of what is written about corporate planning stems from a naive set of assumptions about what counts as a plan in the corporate environment.

The plan, it is assumed by definition, is formulated in advance of events. If so, it seems to follow that means must be devised to effect it – for without such means there is no point in having a plan. Then the process of realizing the plan must be vigorously prosecuted to completion – otherwise the concept of planning itself is nugatory. Then it follows that the success or failure of planning may be measured through the extent to which the plan matures in actuality.

This fourfold set of assumptions appears to be beyond argument at first sight, so why should the cybernetician call it in question ? Simply because corporate plans demonstrably " do not work ". They are not really intended to work, it turns out ; and this is largely because of their time-scale, their reference to very large systems, and the cussedness of events. We can call an intention to buy another company " a plan ", if we wish, and *this* sort of plan we can certainly effect. But " the corporate plan " refers to the long-term future of an entire corporation – and nobody knows to what extent it will need to be continuously modified. Surely, though, it must be modified to a very large extent ; because the situation changes continuously, and the corporation has control over a mere fraction of the situation in which it inheres. Therefore we ought not to expect that any corporate plan, depicted at this instant, will ever be realized in this form.

Then it might be asked whether there is any point in formulating a plan which is not expected, nor perhaps even intended, to mature. The answer is that there is a point, but it is not the point made by the naive set of assumptions – which really says : " decide what to do for the best, then do it ". Large systems, working over a long time-scale (which admits no crucial day of judgment), are very short of information – about themselves, about their environments, about what is going to happen, and about when the crunch will come. So any decision now about " what is best to do " is incompetent, and it could always be more competently taken tomorrow – by which time there will perforce be more information on all four points. Yet this recipe for procrastination invites the abdication of management, which is normally reckoned to accept responsibility for decision-taking under uncertainty.

To resolve this dilemma we must understand that the manager's decision-taking task happens today, although it relates to the future. He decides about the future today, on the strength of today's information. Then when tomorrow comes, and provides more information, in principle he *must change his decision.* To ignore the new information is incompetent. In practice, the manager's new decision tomorrow will often – perhaps normally – be indistinguishable from today's : because the information changes marginally, while the decision probably has an all-or-none quality. Even so, a corporate plan refers to an indefinitely long series of tomorrows, and to a complex set of decisions, and the quanta of information which accrue daily may in the long run significantly change any given contributory decision. Thus it turns out that corporate planning is a continuous process, directed towards the adaptation of contemporary decisions about the future to the continuously present state of knowledge.

Looking over the original assumptions, then, it is true that corporate plans look forward, but it is also true that they do not in general mature. Therefore the sense in which they can be " prosecuted " is very special, and the means selected for effecting them must not – as often happens – rebound to make them rigid. Corporate planning becomes a machine for sequentially aborting incompetent plans. Planning is essential, if the enterprise is not to be randomly perturbed by the interplay of future events. But, paradoxically, the next most important feature of corporate management is the organizational capability to abort the plans on a continuing basis.

All this is about adaptation. Adaptation is the crux of planning, although it is not its ostensible object. The ostensible object of planning – a realized event – happens from time to time as a fall-out of the planning process which passes it by. The real object of corporate planning is the continuous adaptation of the enterprise towards continuing survival.

The corporate will to survive is real, and corporate foresight is a possibility. There is no plan, to be determined now and adhered to, which will guarantee that survival. There is however a planning process, which is continuous, aimed at adapting the enterprise to a changing environment – and fitting it, therefore, to exploit its opportunities. This seems to sum up the issues.

What, then, is this planning process which sequentially aborts its actual plans ? It is founded in organizational structure, because this structure alone is that which adapts. Plans will be changed, we said, in the adaptation process ; but it is not really the plan itself which adapts. A plan is an unreality, the organization is real. If the structure of organization is not adaptive, the organization cannot effectively change its plans. If the structure is adaptive, the organization's plans will not remain the same for long.

Hence we are led to talk about organizational structure of an adaptive kind ; and from this discussion it will be possible to educe the nature of corporate planning as an aborting process which facilitates adaptation of the enterprise for survival.

It has never seemed likely to me that the organizational structures with which we are most familiar display the adaptability we are now seeking. They were devised to meet a situation governed by a leisurely rate of technological change ; a situation therefore which posed few problems of sudden and perhaps annihilating competition. Management machinery could afford to be slow and ponderous, as it was anyway bound to be. For its metabolism consisted in mobilizing the insight and decision power of groups of people to deal with a relatively constant environment by social means. Today, because of the rate of change, the metabolic rate of management needs to rise rapidly, and beyond the capacity of the purely managerial group. Scientific method, coupled with the logical power and data processing capacity of the electronic computer, fortunately provides the means.

But a new sort of structure is required to exploit these capabilities. What it is certain to have in common with familiar structures (and perhaps it is the only common feature) is *hierarchy.* The notion of hierarchy is given in cybernetics as a necessary structural attribute of any viable organism. This is not surprising to us, although its theoretical basis is profound, because all viable systems do in fact exhibit hierarchical organizations – and we are used to this. We shall investigate the problem of adaptive management structure, then, with this notion of hierarchy as given.

2. THE ANATOMY OF MANAGEMENT

Hierarchies of Command

We need an intrinsic command or control system simply to work a machine tool properly –it is part of the machine. But we need a second level of command to run a machine tool *effectively*– that means to copy or to translate the human sequencing capability. And if we take a factoryful of computer controlled machine tools, we shall rapidly disclose the problem of next higher order, which is how to sequence *those*. The solution to this entails a third level of control. Here, most interestingly, we promptly outrun the human capability. Men themselves cannot do the job. They can plan the work of the factory on some kind of Gantt chart, it is true, and produce a feasible answer. But they cannot find the uniquely optimal plan for utilising the machines in relation to material stocks on the one hand and the order book on the other. To find a formal optimum requires advanced mathematical techniques, and a computational capacity beyond that of the human brain. So we have reached a point where machines that merely translate the human sequencing control capability are inadequate, and must be turned into amplifiers.

Again we have the answer in the electronic computer – but it is working now a further step up the hierarchy of command. This is a computer to control the computers which control the tools. The hierarchy of command is extended to a third level.

What then is this machine that controls a machine to control another machine ? And if it must eclipse the capability of the human brain in certain respects, what human capability is it amplifying ? The simplest answer to the second question, given without semantic cavilling, is that it amplifies intelligence. As to the first question, the modern computer (including storage) is larger than the brain, may contain more than the brain's 10^{10} decision elements, and has greater memory capacity more reliably accessed. Moreover, whereas the brain qua computer works in the millisecond (10^{-3}) range, the computer qua brain works in the nanosecond (10^{-9}) range. That is to say, the computer's basic speed of operation is a million times as fast as that of the brain. The computer does not have all the advantages, but it does have these ; nor does it require sleep or relaxation. Of course, it has to be constructed in the first place according to a " genetic " pattern, and it subsequently has to be programmed to gain skill from its own experience. The same is true of a baby.

For reasons which will soon become apparent I shall call the assembly so far discussed System One (see Figure 1). It consists firstly, at level (a), of the basic set of "doing"machines with which we are industrially familiar already – which include their own intrinsic controls. Secondly, at level (b), are the computer controls needed for the sequencing types of activity which make the doing-machine flexible. Thirdly, at level (c), are the computer controls capable of sequencing the sequencers. System One is, in the scheme of things expounded here, a basic component of what will shortly become modern industrial organization. It is already a three-level command hierarchy, but it is itself only the first level of another five-tier hierarchy which is needed to run a business.

System One : Divisional Control

A modern plant consists of machines with their own (level (a)) control devices. When their activities are controlled by computer-driven overlords (level

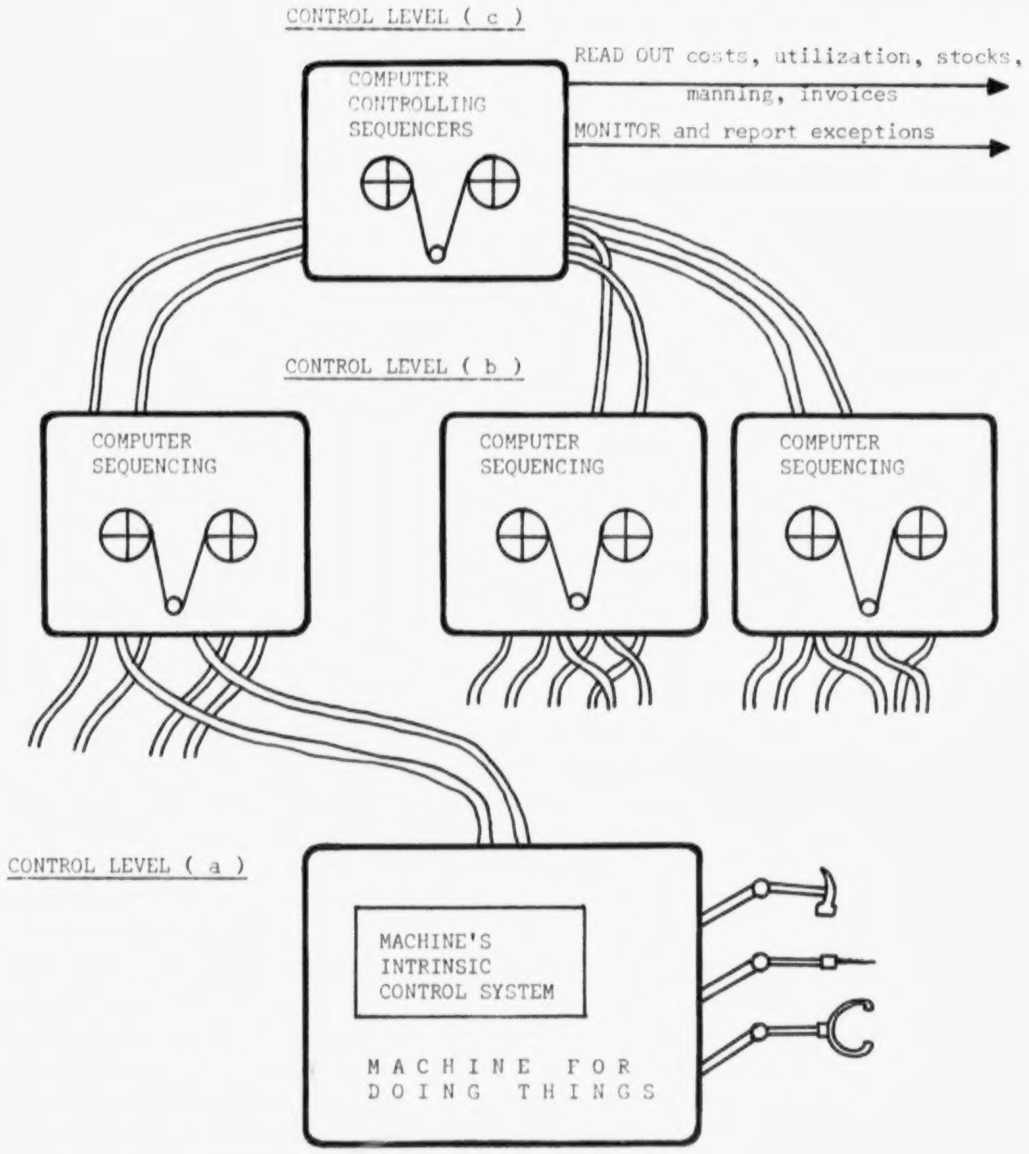
CONTROL LEVEL (c)
COMPUTER CONTROLLING SEQUENCERS
READ OUT costs, utilization, stocks, manning, invoices
MONITOR and report exceptions
CONTROL LEVEL (b)
COMPUTER SEQUENCING
COMPUTER SEQUENCING
COMPUTER SEQUENCING
CONTROL LEVEL (a)
MACHINE'S INTRINSIC CONTROL SYSTEM
MACHINE FOR DOING THINGS

FIGURE 1. The infrastructure of System One

(b)) there exists sufficient electronic awareness of what the plant is doing to feed the inputs of a level (c) controller. The stage in the approach to a " cybernetic factory " has seldom been completed. Exceptions are, perhaps, found in the oil, chemical and automotive industries. But there is no reason in principal why even (the notoriously difficult) jobbing shop production control should not operate System One, and indeed this is the industrial locale where the real pay-off lies. As remarked earlier, the problem of matching the resources which the factory uses to the tasks it must perform is beyond human brainpower to solve optimally, but computers can certainly do it.

System One (level (c)) computers require a detailed information service (from level (b)) about the activities going on, and they need optimizing programs capable of two main roles. The prior role *(mathematical programming)* deals with input-output analysis. Given a range of resources and a range of tasks, what is the best allocation of resources to tasks under some cost-minimizing criterion ? The scientific techniques required to handle this role are well-known. The missing links in practice are usually the communication channels to connect control levels (b) and (c). They can be provided.

The second role *(stochastic programming)* deals with the interactions, not of fixed quantities, but of probabilities. There is a measurable profile of the risk that a particular spare part will be required in the factory, for example. There is also a measurable profile of the chance that the relevant spare part will be available. The interaction of these two profiles determines an optimal stock level under any given criterion of risk that the stock will run out. Again, the scientific techniques required are well known. The missing link in practice this time seems (unhappily) to be managerial understanding.

No attempt is made here to exhaust either the list of typical managerial problems on this level or the use of operational research techniques available to solve them. (A good account of all this is to be found in reference 1.) But the two roles just discussed are most important, because most of the problems in System One turn out to be some amalgam of rigorous optimizations and the calculation of risk. In Figure 2 is depicted a System One controller operating on " a business " – in which sits a management. For the sake of the rest of the argument deployed here, this business will be considered as one division of the firm with whose overall control we shall be concerned.

(1) Rivett, B.H.P., and Ackoff, R.L., *A Manager's Guide to Operational Research,* John Wiley, London, 1963.

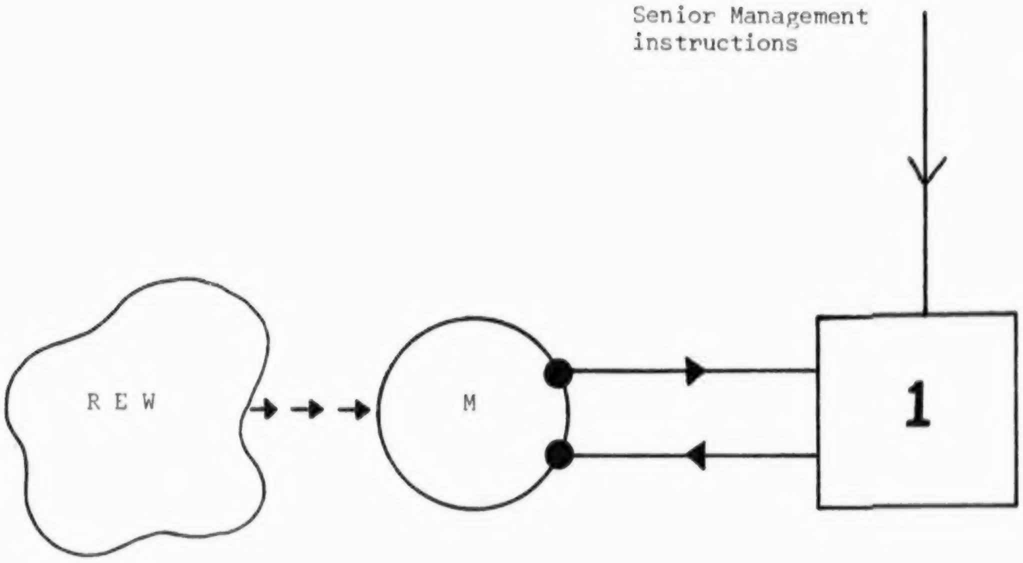
Senior Management instructions
R E W
M
1

FIGURE 2.

The relevant external world (REW) batters the business division (M), which uses a System One controller to maintain control.

The reason why the diagram is absurdly simple is that, from the whole firm's management standpoint, this particular divisional operation is virtually autonomous. It is none the less difficult a problem for the managers *inside* it for that. And although we have argued that there are adequate scientific techniques for handling the control loop depicted in the diagram, there is at least one either major problem indicated there which needs a lot more attention. Look at the round blobs which initiate control data and receive information back. These are the transducers. A transducer is a device which " leads across " (to follow the Latin roots of the word precisely). Inside the divisional circuit many, many events take place ; how should information about them be led across to the System One control ?

The events themselves have to be registered, to be coded, to be turned into some kind of control data in machine-reedable form. When the control is operated, its statements need reinterpretation in the world of events – and we have another translation and transduction problem. Insofar as System One is a computer, then the events must be electronically recorded by one means or another. If we are seeking to transduce data about machinery, the problem is minimal – because we can probably contrive to read the state of the machines from their own intrinsic (level (a)) control circuits. But when men are generating the events, they have to be trained to record what they are doing through key-boards (for example) which generate punched cards or magnetic tape.

System Two : Integral Control

If we call each natural division of the total firm a System One controlled operation, then the entire activities of the firm may be depicted as in Figure 3. This is a firm having five divisions, each of which has its own System One controller, its own unique problems of transduction, and its own special control techniques. Then what makes this collection of separate divisions into a firm ?

It has to be the connectivity of the divisions – which may be strong or weak. A strong connection is found in the kind of industry which, like the steel industry, passes its product from one division to the next. Iron-making is a business in itself ; but the iron is passed to a steel-maker – and he in turn must get his product rolled and re-rolled. A weak connection is found between divisions where products are wholly dissimilar, and whose enterprise serves different markets. In this case the nexus between the units may be basically financial, and the firm's cohesion largely a matter of psychology – the image of the enterprise which is disseminated from above.

Whatever the form of connection, it must be there – the thick line shown in the diagram indicates just that. And now we encounter a most important phenomenon of control. Consider the central unit with which we began, controlled by the original System One. It is trying to optimize its performance in relation to an outside world depicted in the Figure as " battering " the unit along a dotted line. But it has two other kinds of input altogether.

The first is a set of instructions from the firm's top management about how the unit is expected to behave. (This input was specially marked in Figure 2.) The second consists of inputs from the two adjacent managerial units (marked " X " and " Y " in Figure 3).

The trouble now is that the " X " inputs are themselves not only subtle and complex, but the result of active optimization procedures irrelevant to the central unit (M). All three divisions behave according to control systems'theory, as it is found in servo-mechanics, and we can predict the inevitable result. The central unit " M " will try to accomodate the received " X " and " Y " optimizations, will produce its own optimum, and thus in turn begin to modify both the " X " and " Y " activities all over again. This will perturb the equilibrium of the " X " and " Y " solutions, which will themselves alter, once again perturbing the central unit " M ". In short the entire system will go into oscillation.

When this happens inside a machine-tool we call it *hunting*. When it happens in the human being, as it sometimes does owing to a defect in the cerebellum, it is called purpose tremor or *ataxia*. The defect is also seen frequently in managerial situations : stocks, for example, may go out of control for precisely similar reasons. To control this kind of oscillation we need a higher-order command structure – and this is System Two. It is a unifying controller capable of damping-down the oscillation of all the Systems One within an overall strategy (see Figure 4).

System Three : Internal Homeostasis

From the standpoint of the firm's top management, the five divisions are now in a stable situation. Each is reacting to the " battering " of the outside world and at the same time accommodating both the firm's policies (coming from above) and the trouble caused by its sister divisions – through System Two. The cybernetician calls such an arrangement a *homeostat* (1). This means a control existing to hold the critical variables of a system within physiological limits. The human body's capability to keep its own temperature fairly steady is

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(1) Ashby, W. Ross, *Design for a Brain*, Chapman and Hall, London, 1954.

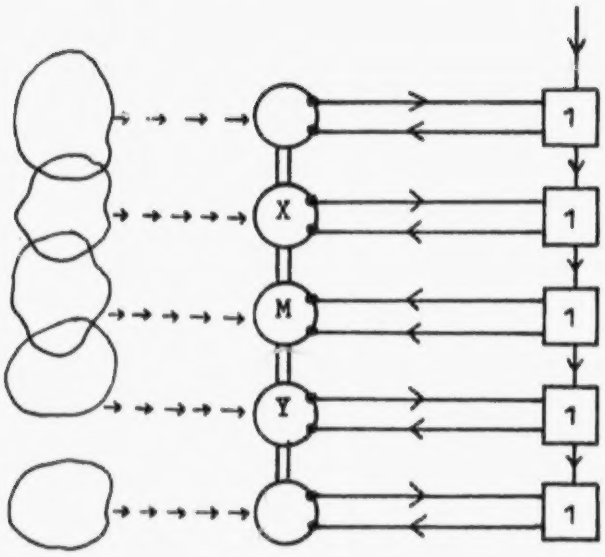


FIGURE 3.

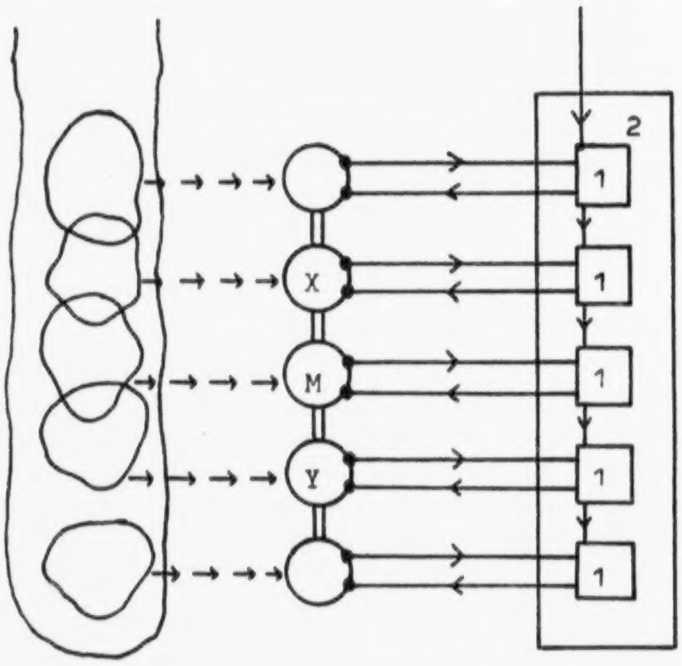


FIGURE 4.

homeostatic – so is whatever control system in a firm that steadily maintains the return on capital invested at (say) 15 %.

It should be noted here that control in large systems turns out to be mainly about stability – rather than the obsessional pursuit of high profits or any other maxima. But the top management of the firm, despite its commitment to some kind of stability, is none the less interested in particular goals. Its method of interfering with the homeostat is already visible in Figure 4 – as a line descending from the clouds. But these instructions, together with a superior view of the world environment in which the firm is set, must be interpreted downward – and this is the function of System Three, which is shown in Figure 5.

Again we meet a higher-order language, and a notion of control which does not belong to the lower-order systems. The divisional units are concerned, quite properly, to do the best they can, within the constraints of good order imposed by System Two. Thus they reach a homeostatic equilibrium. But in the light of knowledge available for the first time at level three, there is more to be done than this.

The function of System Three is to reassemble *relevant* data about the firm's operations into an input-output matrix which can be studied and optimized anew in the light of the firm's overall objectives. Quite specialized information as to what goes on in the operating divisions and their System One controllers will be required. There is of course an ascending stream of information (now added to the diagram) informing top management about the state of affairs. But this has to report what is exceptional – which means that Systems One and Two are actually filters. They do not transmit everything they know ; if they did, the senior echelons of the business would be engulfed.

So we have the important concept of a two-dimensional control operation. There is a central command axis, now starting to appear as a vertical column in our diagrams, and a horizontal command axis working through a different set of criteria.

The scientific techniques available to System Three are primarily the modern forms of input-output analysis which began with linear programming. At this level we can for the first time compute with the firm as a whole. This means solving the vast set of equations that allocate particular resources to particular goals, and obtaining from the large number of possible solutions that which most nearly meets the firm's overall objectives. From the computation should emerge a homeostatic strategy for the firm as a whole. This relates the *internal* homeostat to the firm's environment, through its distinctive policies.

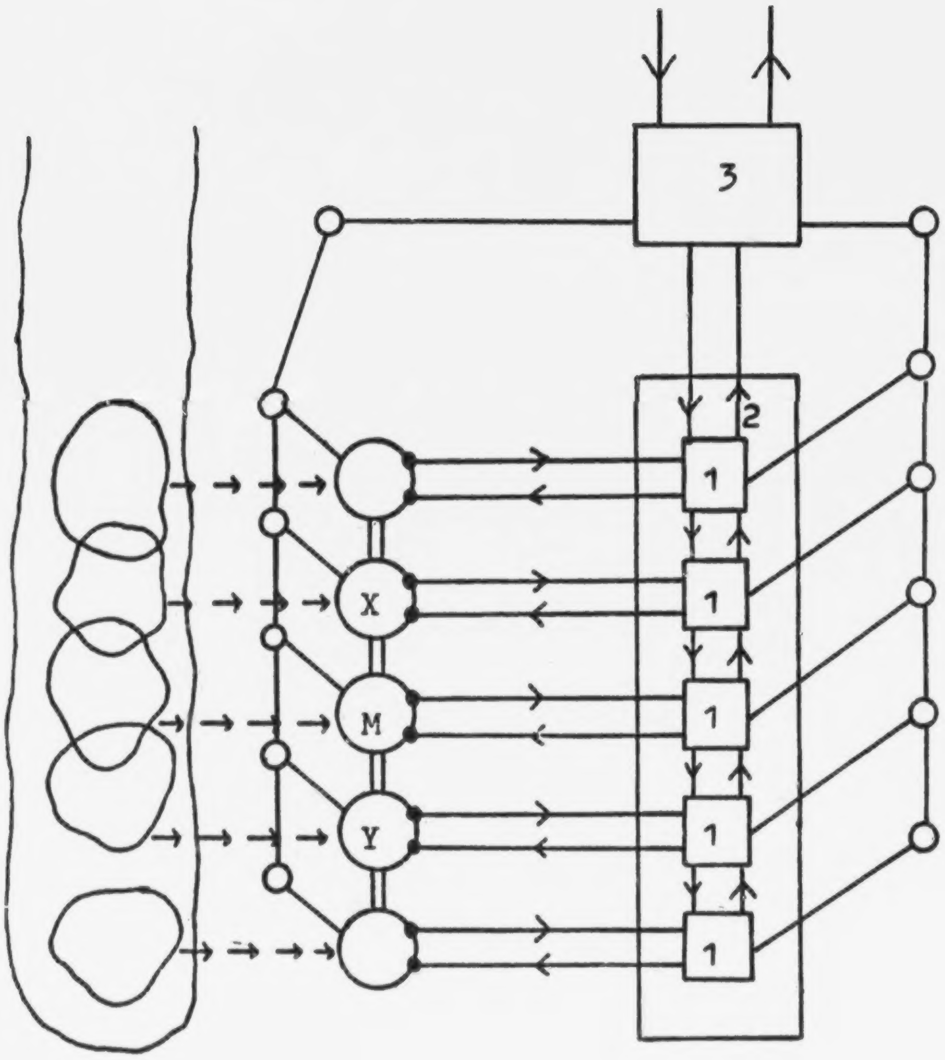

3
2
1
1
1
1
1
X
M
Y

FIGURE 5.

In particular, such worrisome problems as the allocation of total resources between divisional units, and the transfer prices to be used in internal dealings, are here solved. These and similar issues ought to cohere the company in integral activity – but they are normally divisive.

System Four : External Homeostasis

The information available to System Three is of three kinds. There are data rising from below about the internal company homeostat. These are derived either through the filter of System Two, or, where special performance is concerned, from System Three's own antennae. There is descending information from the top management, using what we shall soon call System Five, being filtered down through a staff function – which is now nominated as System Four. And thirdly there is corporate information about the outside world which it is specifically the job of System Four to collect and to distil.

In Figure 6, this picture is made plain. It may not, however, be clear in what respect the world interacts with the firm corporately, as distinct from the operating divisions of the firm. There are at least two important modes in which to understand the distinction. The first is marketing, because marketing the firm itself is distinct from marketing the firm's products through its discrete divisions. For example, a division may interact with other major companies, with export markets, and above all with government, on a lesser scale and in its own distinctive ways – behaviour which the firm as a whole may transcend. The second distinctive mode in the firm's corporate activity is finance – its whole investment programme, its relations with the stock market, and so on. These evironmental transactions must take place through System Four.

Now we met a model of the firm of a specialised kind in System Three. Here is another. This model is also concerned with investment, but not from the internal input-output standpoint. It is concerned with the money market : the raising of money, the company gearing, the relationship of profits disbursed to profits ploughed back, and the bearing of all these on the prices of its shares. In Figure 7 is a copy of an actual conversation with a computer at this level of control. The model inside the computer is being used not directly to control the company's operations, not just to retrieve stored information, and certainly not to compute optima. Its use is *conversational.* The managers responsible at level four, including for instance the financial director, may set up a long computer conversation with this model of the business, and plan their future financial policies well in advance. As can be seen from the chunk of output here reproduced, the computer will ask for possible decisions, apply them to the model, and work out the consequences. Whereupon the operator may be asked for a new decision ; or it may be pointed out to him that he ought to revise old ones.

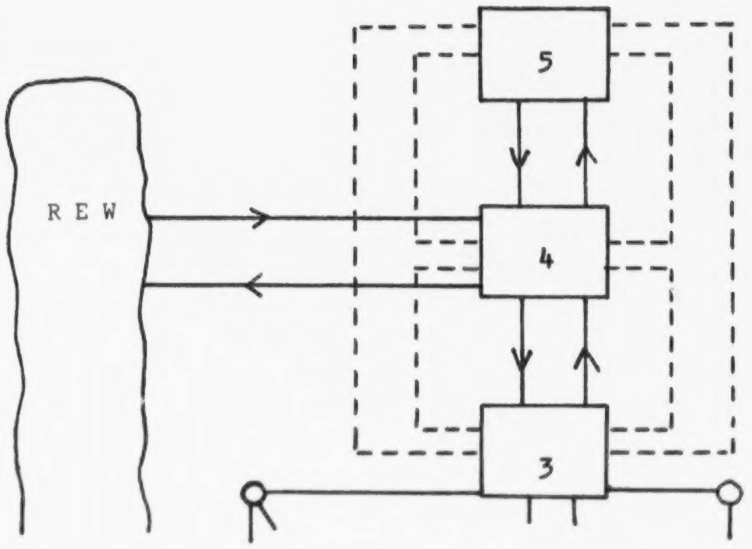
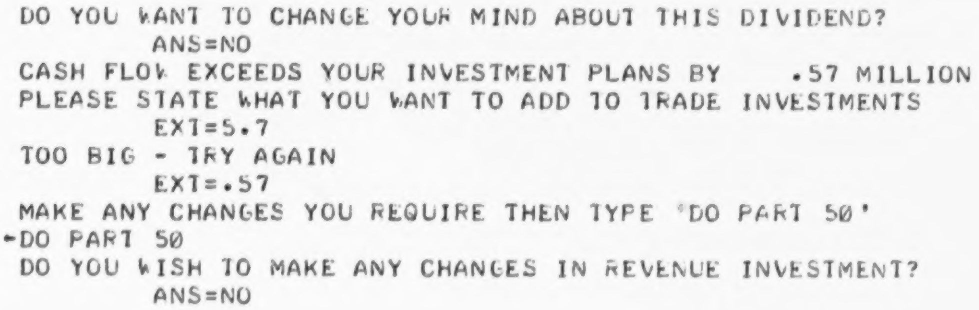


FIGURE 6



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DO YOU WANT TO CHANGE YOUR MIND ABOUT THIS DIVIDEND?
        ANS=NO
CASH FLOW EXCEEDS YOUR INVESTMENT PLANS BY     .57 MILLION
PLEASE STATE WHAT YOU WANT TO ADD TO TRADE INVESTMENTS
        EXT=5.7
TOO BIG - TRY AGAIN
        EXT=.57
MAKE ANY CHANGES YOU REQUIRE THEN TYPE 'DO PART 50'
-DO PART 50
DO YOU WISH TO MAKE ANY CHANGES IN REVENUE INVESTMENT?
        ANS=NO
```

FIGURE 7

System Four computer output. The machine is doing the questioning, the company director answering is investigating possible financial alternatives in conversational mode.

System Four sits squarely on the central command axis of the firm. One of the consequences of the model we are constructing is the view that what management has always thought of as " the staff function " is really not the so-called advisory activity in which its occupants sometimes take refuge. Consider : " Course A is ruinous, I think, and Course B highly profitable. But take your choice. It is not for me to arrogate to myself the role of manager ". This can surely not be called " advice ", when it contains an implicit decision (unless you think the man is mad). A great deal of professional service is of this kind, although it is not presented so crudely ; and it should be recognized as the contribution to actual management that it truly is.

System Five : Foresight

The argument earlier on whereby we established the necessity for a hierarchy of control systems is theoretically absolute. This is to say, there is *always* a higher-order controller than the one we are discussing. It is in strict logic not possible to stop anywhere at all : one has to create or to contemplate the next higher meta-system. But this is like saying that a division of a firm should remember that it is part of the firm ; and the firm should remember that it is part of an industry ; then there is the nation, and Europe, and the world.......... Operational realities must stop somewhere ; because a firm too conscious of its responsibilities to the human race at large, or to a supposed cosmic plan (which might very well include this firm), will go bankrupt. The firm accepts an arbitrarily truncated series of social systems in which it has a place. Likewise, any hierarchy of control stops arbitrarily when it recognises a " final authority ". (Perhaps this is really what the concept of God means in theology.)

The Board is served by System Five – as well as by its dependent systems One to Four. For the Board must consider policies which are almost philosophies, or at least superior in some sense to the practical strategies considered by System Four. And System Four itself will assuredly pose problems upward to the Board – which it may inform but not usurp.

The kind of computer control theory appropriate to System Five is based on yet a third kind of model of the firm, and a new set of operational research techniques. Recapitulating : System Three includes a model of cost-effectiveness, and System Four models of marketing and finance. The model for System Five should incorporate every feature of *the company in its environment* which seems relevant to a consideration of the firm's long term future. It must be capable of reflecting on totally new departures in policy.

The technique for running such a model is ultra-rapid simulation. Suppose we change certain fundamental features of the business as we know it – change the location of the factories and the distribution arrangements, engineer a merger with another firm, or explore a whole novel development in a new technique. What is likely to happen ? The future is known to no-one save God, and the sense in which science can predict is quite different from fortune-telling. We do not know what will happen, but we may be prepared to put limits on the range of likely events.

It follows that we can test our policies against combinations of possible futures – or could do, if we had the time. In our own selves we call this trick *foresight*. We ask what is likely to happen *if* we do this, and then test the likely outcome of our own next responses, and so on. The object, I repeat, is not to foresee events but to map out viable strategies.

With modern high-speed computers we do have the time to replicate experiments ranging over combinations of possible events. We see a course that by defined criteria will leave us least vulnerable. So the object is not to pretend to a knowledge of the future we have not got, but to circumscribe the area of risk. Many mathematical techniques are available once we have a System Five model, and provided that we can make it work. But it has already been made to work in many industries (1).

The Cybernetic Firm

In fact System Five has often been designed and used – not indeed in the role of a System Five, but as a distinctive piece of research. The same is true of System Four and System Three. What has not been properly explored is either the interaction of these three types of models of the firm (see the dotted lines in Figure 6) or their response to real-life inputs – as provided for by this whole theory. The normal practice in operational research work is to use synthetic data to activate models, by regenerating historical data according to statistical sampling routines. But in a five-tier hierarchy of control systems of the kind described, the models would be continuously activited by real data – namely the information flowing throughout the firm.

Since types of each of the five systems have been proved to work, it must be possible to make the entire arrangement work in aggregate. And this is no distant dream. It requires managerial insight to commission and to effect ; it requires a great deal of computer application work. But it, or something like it, will be done. Whence comes the confidence behind that assertion ?

(1) Beer, Stafford, *Management Science,* Aldus Books, London, 1967.

The answer lies in the formal study of cybernetics. The science of control analyses elaborate systems, seeking out the control functions which make them viable. Now the model briefly described here is a cybernetic model of a viable control organisation – it is, in origin, a model of the human nervous system. This is how it works :

The company divisions are the body's major organs (the liver, heart, lungs and so on). System Two is the spinal cord ; and the Systems One are its vertebral segments, working through reflex arcs. System Three is the autonomic nervous system, and the special-purpose inputs and outputs described are the sympathetic and parasympathetic trunks. The control centre of System Three in the body is the hind-part of the brain (pons, medulla, cerebellum). System Four is the middle part of the brain, through which pass all sensory data on their routes from the sense organs. System Five is the cerebral cortex itself.

This short explanation may make the whole theory easier to understand, or not. But it does indicate the power of cybernetic thinking. For the argument is that viable systems are organised like this – whether they are physical, biological, social or economic. That is because there are general laws of control in nature that are of universal application, and each viable system is a model of any other (1). So I do not argue that a firm *ought* to operate like this ; I argue that a firm *does* operate like this. What I have done is to offer a systematic explanation of how this happens.

What we can fully understand we can certainly automate. For there is no technological problem left – there are only problems of structure (which can be solved by cybernetics) and problems of finance (which may take longer).

There is a final mystery to elucidate. If viable systems work like this (and Figure 8 shows the complete picture), then surely we should have used the full five-tier model to account for divisional control, instead of the three-tier model advanced at the beginning. This is true. (Few mysteries clear up as quickly as those which do not really exist). We began, in fact, by talking about machines operating at three control levels – (a), (b), and (c). But if we had gone on to consider the senior management of the divisions, we should have run into Systems Four and Five as well. As we now know, these have automated versions too. So it really is five systems : I cannot make them fewer, and there seems no need for more.

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(1) Beer, Stafford, *Decision and Control*, John Wiley, London, 1966.

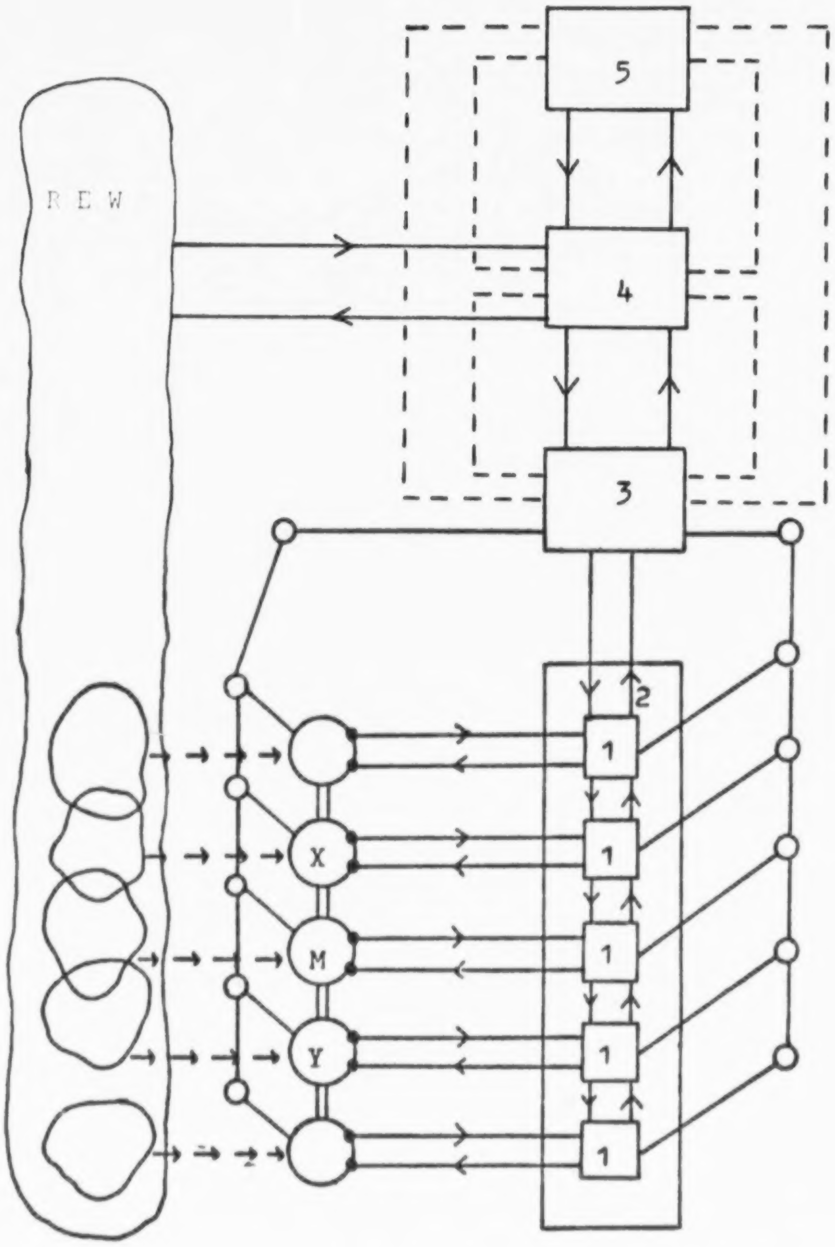

5
R E W
4
3
2
1
X
1
M
1
Y
1
1

FIGURE 8.

Thus we advance to the cybernetic firm – a firm whose control structure is fully understood, and will be automated. It will consist of machines controlling machines controlling machines controlling machines controlling machines having their own intrinsic control. But even without this final degree of automation, we now have a model of company structure which envisages the firm's organization as an hierarchical controller.

3. THE INTERFACE QUESTION ITSELF

All this has been said : and what has it to do with corporate planning ? The reply must be that we have now solved the entire problem, because we have come to a description of the corporate management which depicts it as a controller.

Return, first of all, to the first part of this paper, and to the " naive assumptions " about planning which were criticised there. The argument was that we needed a sequentially abortive corporate plan, and not a concrete unreality called " the plan " which could not (competently) be adhered to. If the plan has to be continuously adjusted as the adaptive capability of the firm operates, then the entire organization must needs fulfil the function of a controller – in the control engineering sense.

Here at last is the meaning of the plan/action interface. As long as plans are pipe-dreams, conceived in a back room (on however knowledgeable a basis, on however profound a theoretical model), so long will they be incapable of realization. Firms have stumbled on this truth, and so above all have nations. Hence the pejorative use of the word " planner ", for instance, in ordinary society. There is a gap between theory and practice, between intention and performance ; and this gap cannot be crossed by will-power, good intention, social motivation, harsh discipline, or even by Board or Government ukase. The continuously abortive plan, however, is formulated today for a tomorrow which – unhappily – cannot be dated : it must therefore be adjusted continuously in the light of new information. It is precisely a controller (in the engineering sense) which meters performance against theoretical capability, and continuously feeds back the error signal which makes adaptation to a changing environment possible.

Provided that we can visualize the organization as a controller, and provided that we can structure it to this behavioural end, the interface problem dissolves. There is no absolute plan which inevitably fails at the action interface. There is no fortuitous action which fails, at the interface, to conform to the absolute plan. There is a tracking action (control engineering), a natural selection of mutant possibilities (biology), an input-output equilibrium state (economics), a latent energy equation measured in terms of entropy (thermodynamics or information theory)... in a (cybernetic) world there is homeostasis between NOW and THEN.

In System Three we have a mechanism, analogous to the autonomic nervous system in the body, which can perform this homeostatic control action for the totality of corporate divisions which adds up to their sum. The body is a collection of inter-relating organs, and so is the firm. They must be integrally managed, to the corporate benefit ; they must not be separately managed, sub-optimally, so that their joint action is inimical to the corporate survival. Having said that, we have said more than most firms (let alone nations) competently achieve ; but we have said almost nothing. For it is nugatory to say to an organism : do not, pray, commit suicide. There is, there has to be, something further worth saying.

This has to do with the exploitation of corporate resources, in a manner which means that the totality of corporate divisions adds up to something much greater than their sum. I, the author, and you, the reader, are between us worth about a shillingsworth of chemicals : this is the sum of our components' value. But neither of us would concede that our value as individuals is no more than sixpence. Nor do we think of ourselves as blood-pumping machines, or devices for protein synthesis. We manage to deploy corporate resources to more impressive ends. Similarly, with the firm, the divisional structure – *any* divisional structure – is a precondition of the corporate reality, but not its strength. The sum of divisional plans may (and indeed should) be profitable. At the System Three level, the *inter-related* divisional plan may (and should) be more profitable still. But we have not begun to use the corporate strength – the individuality of the firm as a whole, the diversity of the firm's parts considered as a corporate entity.

System Five is needed to encompass these possibilities : in the contemplation of possible corporate futures, in the evaluation of alternative business strategies, in the formulation (that is) of corporate policy. But although System Five activity is encompassed by the corporate model, its planning could still operate in mythology, in a world of unreality ; it could still be divorced from the pragmatics of System Three optimizations of what is actually going on NOW. The bridge between that fifth level THEN and the third control level of NOW *is* corporate planning – precisely the function of System Four. If we must have a locale for our interface, here it lies. Yet within the organic model of Figure 8 it is still seen to be a structural component of management, intimately related to the NOW and THEN (Systems Three and Five), and not a back-room generator of castles in Spain.

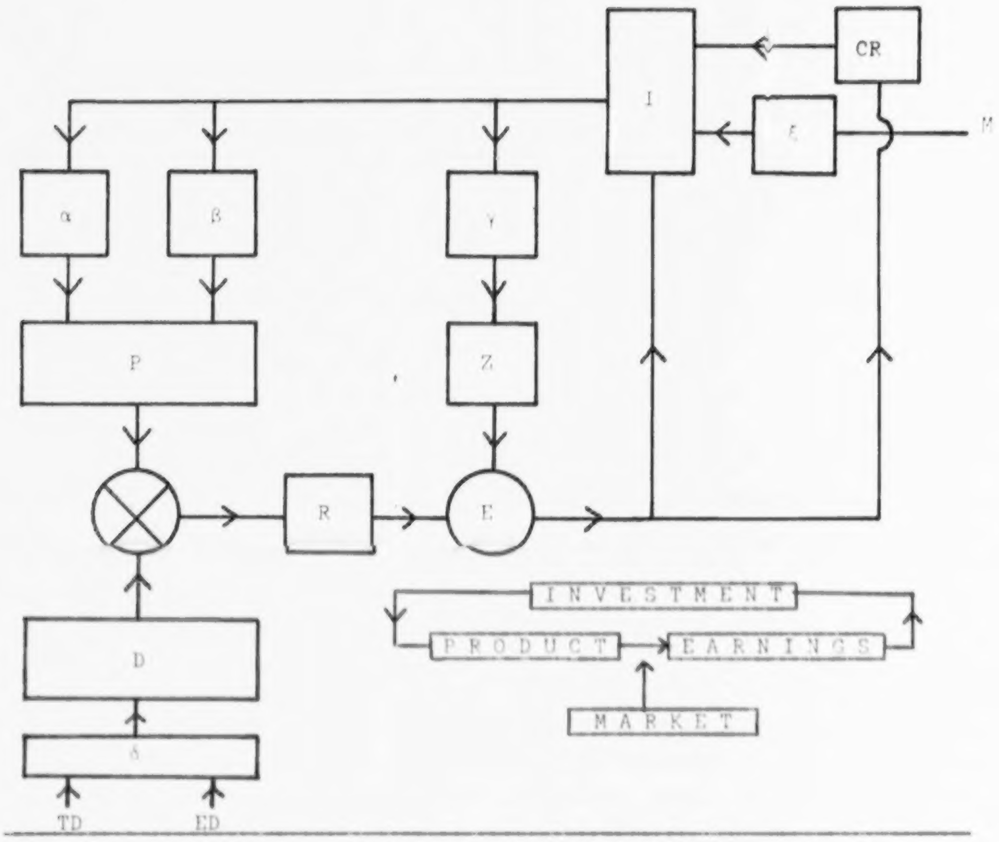
Consider again the anatomy and the physiology of this critically placed System Four. It receives both inspiration (the " foresight ") and instruction (the " ultimate authority ") from above (Five). It receives both practical understanding (" the facts ") and pain/pleasure arousals (" management by exception ") from below (Three/Two-One). It receives thirdly the whole sensory input from the corporate environment. Therefore it is ideally placed continuously to evolve and continuously to abort the corporate plan.

We said that this plan must (managerially) be about adapting the organization towards survival, and we said that (cybernetically) the function is homeostatic. We could use any kind of model we liked, provided that it manifested viable characteristics, to discuss System Four. But because we focus attention on the control function of the corporate plan, it is well to derive a model from control engineering. The following model (see especially Figure 9) is due to R.H. Anderton (Management Cybernetician at IPC Ltd).

The company may be viewed as performing two kinds of regulation or control. It must control earnings at a (preferably steady) level above some minimum necessary for security. Secondly, it must control the match between product attributes and market demand. There are at least two major disturbing inputs against which this regulation is performed. They are variations in the environmental economy (especially of the nation), and cycles of technological innovation. There are thus two major regulators. And management organization at Level Four must consist in institutionalizing the control loops associated with them. Generally, the control loops are inefficient in themselves, because the formal organizational machinery does not exist. Secondly, argues Anderton from his model, there is a largely unrecognized coupling *between* the two loops which is destabilizing.

A generalised and simplified version of the Anderton model appears in Figure 9, which shows how earnings regenerate future earnings, and how this flow is " pumped " by the market and its demands. Revenue is shown as generated by the *match* between existing product attributes (including price) and the demands of the market (as conditioned by the economic climate and available technological alternatives for satisfying the same basic needs). Investment funds are divided between product innovation, product improvement, and an increase in operating efficiency.

The value of this servo-mechanical model derives from its dynamic characteristics. It facilitates the examination of corporate plans on the indefinite time-base which (there being no crucial date) invalidates so many


CR
I
ξ
M
α
β
γ
P
Z
R
E
D
δ
TD
ED
INVESTMENT
PRODUCT
EARNINGS
MARKET

KEY:

TD - Technological Disturbance
ED - Economic Disturbance

M - Input of Money

P - Product
D - Demand
Z - Operating Efficiency
CR - Capital Reserve
R - Revenue
E - Earnings
I - Investment Capital

⊗ - Product/Demand Match

CONTROL PARAMETERS:

α - capability to innovate products
β - capability to improve products
γ - capability to improve efficiency
δ - responsiveness (inertia) of market
ξ - power to borrow money

FIGURE 9.

Simplified Control System
Representing the Firm.

static models of the corporate economy. There is, for example, a marked difference in the time constants (the " bandwidths ") of the three investment channels. There is a sensitive (high gain) relationship between product match and revenue performance. But there may well be a sluggish (long time constant) output response to certain kinds of fast-varying input – because of the complexities of the total system, which damp down the initial oscillations. There may also be amplifiers in the system which increase the amplitude of dangerous oscillations that ought to be damped. System Four, clearly, must study all these phenomena through its models ; and it must also monitor managerial action as a generator of oscillation. For one thing is sure about a system of this sort. It is that the control target of steady response, which entails steady profit-making and steady growth, can be achieved only relatively. The important outcome of regulation is to hold the critical response variables within physiological limits.

Corporate planning must, in the cause of adaptation, wrestle with precisely these matters – which are left out of account in traditional planning procedures. Their omission actually *creates* the plan/action interface problem. The major control actions available are the variation of weights between inputs on the re-investment loops, bearing in mind the different time constants of the system, and the managerial control of product attributes themselves. Managements, naturally, operate on all these variables already ; but they do not formally understand the intricate interplay of lags in the system's control responses. Hence (again) management produces a plan/action interface failure which can be accomodated by a continuously operating dynamic structure alone. Secondly, it follows from these servo-mechanical notions that controlling action depends heavily on the use of predictive filters within the system. These do not normally exist, except in terms of an accounting " variance " between budget and performance – which usually procures an undamped managerial response and an uncontrolled oscillation in the system.

Study of the Anderton model quickly reveals that the controllable parameters of the system represent intangible assets of the firm. They reflect the internal capability to innovate, and to be more efficient ; externally they reflect the addictedness of the customer to the product, and the reputation of the business itself. Therefore control actions which adjust these parameters represent major interference with the company's assets, and become powerful determinants of long-term systemic behaviour – instead of being merely short-term " trimmers " of performance (as they may well seem to be).

Secondly, it can readily be seen that the entire system which is the firm is extraordinarily difficult to stabilize in circumstances of rapid environmental change. There is high gain between the economic environment and earnings, while the system as a whole responds in a slow, laggy, noisy way to technological change. Short-term alleviations (" cut the costs ") inevitably produce longer-term adaptive deficiencies – because of the internal couplings between controllable inputs. Moreover, there are *two* control criteria (earnings and the product/market match). This in itself produces problems, but it is evident that the systemic lags are too long to permit control by reacting to deviations in earnings alone.

Much more could be said about the control characteristics of the firm as seen through Anderton's model. But if effective management of corporate resources is to be achieved, it should already be clear that the task is to *engineer* the *structure* of the system to change its time constants, lags, couplings, gains and so forth. Little can be done by mere exhortation of those people who are operating the structure, however exalted or well-meaning they may be. Furthermore, the move of a singularly dynamic manager to intervene drastically in the system – to short-circuit its natural behaviour for instance – may well perturb the dynamics further and in unknown ways. This adds to the artificial " interface " problem under discussion, because it further dislocates the continuous homeostatic interplay between what counts as planning and what is observed as action.

The final diagram (Figure 10) depicts a more detailed systemic model of corporate finance. It was produced by B.E. Baldrey and his team (also at IPC Ltd) and is operated by a computer program devised by Dr. K. Feldman. This model underlies the conversational mode interrogation system discussed earlier (and see again Figure 7). It is a prototype of a tool of management which must rapidly become universal if the plan/action barrier is finally to be destroyed. For here the most senior managers may hold their meetings around the computer console, continuously simulating their possible courses of action, continuously eliciting the elaborate systemic consequences of every simulated decision, and thereby evolving plans whose viability and vulnerability are not only known but understood, not only understood but " experienced " in advance. An excellent account of the management style to which this development would conduce has been given by Dr. A. Crawford (1).

In conclusion, then, the interface between planning and action is seen as a shifting, amorphous, tenuous line which divides intention and realization at the moment of irrevocable decision alone. Before that unique moment, intentions

(1) Crawford, Alan, Brave New Business, *Management Decision*, Spring 1967.

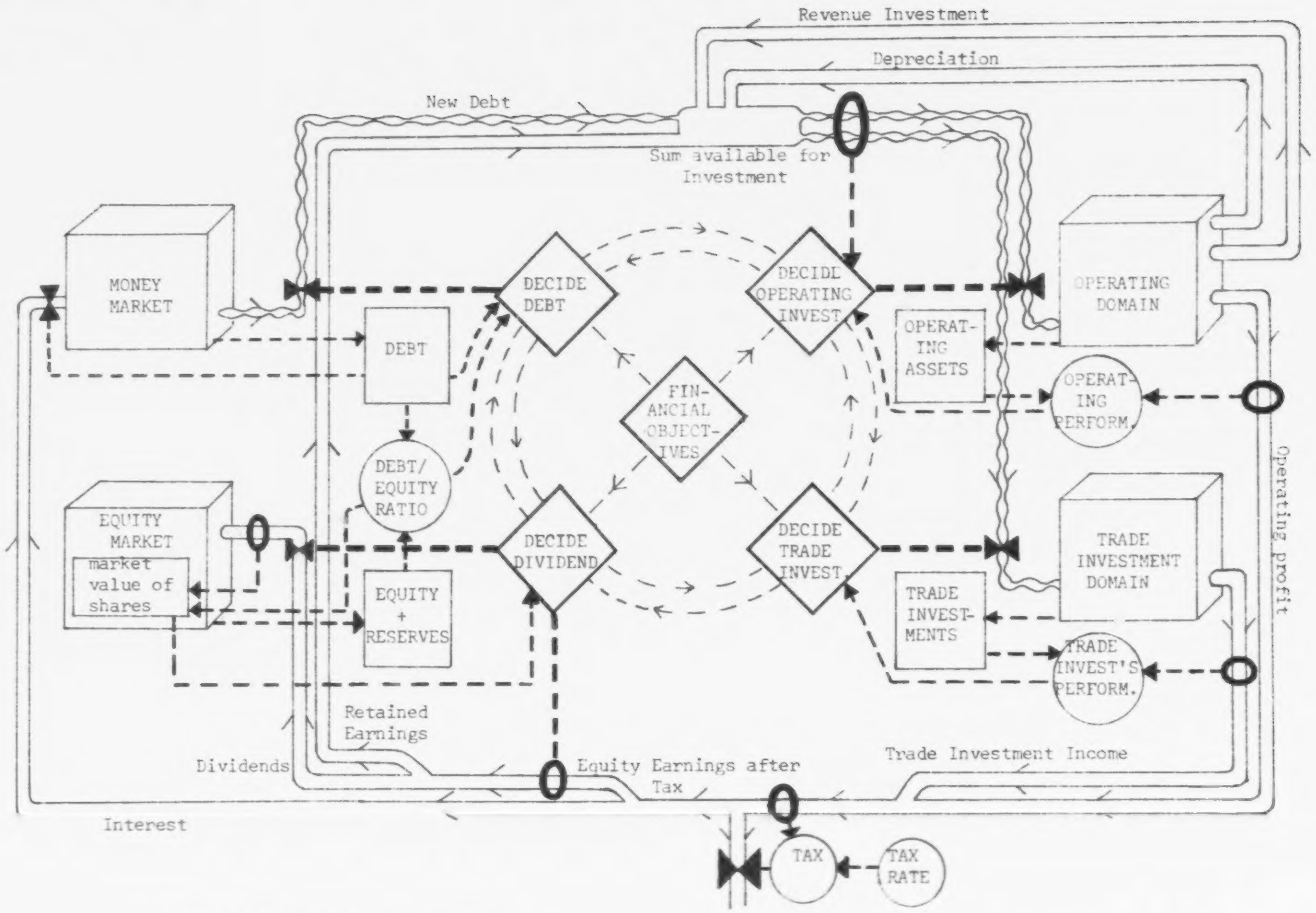

Revenue Investment
Depreciation
New Debt
Sum available for Investment
MONEY MARKET
DECIDE DEBT
DECIDE OPERATING INVEST
OPERATING DOMAIN
DEBT
OPERAT- ING ASSETS
OPERAT- ING PERFORM.
FIN- ANCIAL OBJECT- IVES
DEBT/ EQUITY RATIO
Operating profit
EQUITY MARKET
market value of shares
DECIDE DIVIDEND
DECIDE TRADE INVEST
TRADE INVESTMENT DOMAIN
EQUITY + RESERVES
TRADE INVEST- MENTS
TRADE INVEST'S PERFORM.
Retained Earnings
Dividends
Equity Earnings after Tax
Trade Investment Income
Interest
TAX
TAX RATE

FIGURE 10. Corporate Finance Model

remain fluid in relation to any specific event. And since events are spread out in time, some being the fruit of short-term and some of long-term decisions, the " leading edge " of the corporate plan is not arbitrarily fixed as" 5 (or 15) years from now " ; it winds through a whole area of future activity, encompassing some near events and some far events in its path. The whole concept contrasts dramatically with the notion of a " five-year plan " – even when this is recast annually. The difference lies between a quantised treatment of time and foresight of information and decision, and a continuum.

If the human being offers a physiological control model of the firm, as in Part 2, then it may help to reflect on the psychology of personal planning as an analogue of corporate planning. We form master intentions (and even these are subject to change), and we adjust all the details of our plans right up to the moment of irrevocable decision in regard to a given event. We do this because we are conscious of the plan at all times, and feed new information continuously into our planning activity. A mismatch between some fairly well formed intention and a new set of facts is at once noted, and the plan is adjusted – unless we are mad. In the firm and in the nation, the plans may be beautiful, but they tend to be filed away ; the enterprise is not alerted to the daily mismatches occuring as actual events unfold.

Then of course planning must be a continuous process, and of course plans must be continuously reassessed in the light of a continuous information input. The problem is : how does a firm have a *consciousness* of the plan ? The answer must lie in new organizational structure, new information techniques – and a new mode of disquisition, which conversational computers alone can provide. They have all been discussed here. They can provide the sequentially aborting plan.

If they can do this for the firm, by the way, they can do it for the nation too. The model, if it is valid at all, is invariant.

A NEW CORPORATE DESIGN

by

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During the last fifteen years there have emerged several important new areas of thinking about the corporation, its purpose, and its management. When brought together, these ideas suggest a new kind of organization that promises major improvements in the way the corporation can serve the needs of man. As yet, no such synthesis has been implemented.

In technology we expect bold experiments that test ideas, obtain new knowledge, and lead to major advances. But in matters of social organization we usually propose only timid modifications of conventional practice and balk at daring experiment and innovation. Why? Surely it is not that present organizations have proven so faultless. Nor can it be a matter of risk, for we spend far more and drastically affect the lives of more people with scientific and product experiments, many of which fail, than would be necessary in experiments with new concepts of corporate design. Perhaps we are victims of a preoccupation with scientific experiment. Perhaps knowledge is so compartmentalized that no one person sees at the same time the evidence of need, the possibility of improvement, and the route of advance. Perhaps we are reluctant to permit changes in the framework of our own existence. But it is time to apply to business organizations the same willingness to innovate that has set the pace of scientific advance.

BASIS FOR A NEW ORGANIZATION

Innovation can only be based on new ideas. These are now available. Four areas of thought, developed in the last two decades, form the foundations for the new type of organization that is here proposed. These four areas cover quite different aspects of the corporation but together they offer a mutually enhancing basis for a new type of enterprise :

1 - New thinking in the social sciences indicates that moving away from authoritarian control in an organization can greatly increase motivation, innovation, and individual human growth and satisfaction (1).

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(1) Hagen, Everett E., *On the Theory of Social Change*, Homewood, Illinois, Dorsey Press, 1962
Mc Clelland, David D., *The Achieving Society,* Princeton, New Jersey, D. Van Nostrand Co, 1961
Mc Gregor, Douglas, *The Human Side of Enterprise,* New York, Mc Graw-Hill Book Co, 1960.
Likert, Rensis, *New Patterns of Management,* New York, Mc Graw-Hill Book Co, 1961.
Haire, Mason, *Psychology in Management,* New York, Mc Graw-Hill Book Co, 1964.

2 - Critical examination of trends in the structure and government of corporations suggests that the present superior-subordinate basis of control in the corporation should give way to a more constitutional and democratic form (1).

3 - Recent research into the nature of social systems has led to the methods of " industrial dynamics " as a way to design the broad policy structure of an organization to enhance growth and stability (2).

4 -Modern electronic communication and computers make possible new concepts in corporate organization to increase flexibility, efficiency, and individual freedom of action (3).

When these four lines of thinking are synthesized into a new, internally consistent structure, we find that they point to a very different kind of organization from that common in business today.

CHARACTERISTICS OF THE NEW ORGANIZATION

The proposed organization can perhaps best be conveyed by discussing eleven of its most conspicuous characteristics.

Elimination of the Superior-Subordinate Relationship

The influence of organizational form on individual behavior is central to the proposed corporate structure. A substantial body of thought, derived from several centuries of politics, national government, economics, and psychology, exposes the stultifying effect of the authoritarian organization on initiative and innovation and suggests that, whatever the merits of authoritarian control in an earlier day, such control is becoming less and less appropriate as our industrial society evolves.

From industrial history, the social sciences, and the observation of contemporary organizations, there emerges a relationship between the methods used for organizational control and the effectiveness and growth of individuals

(1) Eells, Richard, *The Government of Corporations,* Free Press of Glencoe, 1962.
Eells, Richard,and Walton, Clarence, *Conceptual Foundations of Business*, Homewood, Illinois, Richard D. Irwin,Inc., 1961.
Berle, Adolf A., Jr., *The 20th Century Capitalist Revolution,* New York, Harcourt, Brace & World, Inc., 1954.
(2) Forrester, Jay W., *Industrial Dynamics,* Cambridge, Mass., M.I.T. Press, 1961.
Roberts, Edward B., *The Dynamics of Research and Development,* New York, Harper & Row Publishers, Inc., 1964.
Packer, David, *Resource Acquisition in Corporate Growth,* Cambridge, Mass., M.I.T. Press, 1964.
Nord, Ole C., *Growth of a New Product,* Cambridge, Mass., M.I.T. Press, 1963.
(3) The literature is notably weak in treating the philisophy of how electronic data processing can, in the long run, lead to restructured organizations and to environments more attractive to the individual. There has been a tendency to stress the negative short-run trends rather than to develop the positive aspects.

within the organization. The authoritarian and bureaucratic control structure molds individual personality so that the environment is seen as capricious, and lacking in orderly structure and in cause-and-effect relationships. Consequently the individual feels little hope of changing that environment and is not open to information and observations that would lead to improvement. (See the reference by Hagen).

If the authoritarian hierarchy with its superior-surbodinate pairing is to be removed, it must be replaced by another form of discipline and control. This substitute can be individual self-discipline arising from the self-interest created by a competitive market mechanism.

To depart from the authoritarian hierarchy as the central organizational structure, one must replace the superior-subordinate pair as the fundamental building block of the organization. In the new organization, an individual would not be assigned to a superior. Instead he would negotiate, as a free individual, a continually changing structure of relationships with those with whom he exchanges goods and services. He would accept specific obligations as agreements of limited duration. As these are discharged, he would establish a new pattern of relationships as he finds more satisfying and rewarding situations.

The guiding policy structure and accounting procedures of the system must be so adjusted that the self-interest of the individual and the objectives of the total organization can be made to coincide. Education within the organization must then prepare each individual to use his opportunities in that self-interest.

The non-authoritarian structure implies internal competition for resource allocation. Prices of individual skills, capital, and facilities would rise to the highest level that could be profitably recovered by the various managers who sell to the outside economy. An internal price that is higher than an external price for the same resource would reflect a more efficient and effective internal use of that resource than is possible in the external economy. Such internal competitive allocation of resources would contrast to allocation by central authority as is now practised by industrial corporations.

Individual Profit Centers

If resources are allocated not by the edict of higher authority but according to the value of the resource to the individual members of the organization, there must be a basis on which each member can estimate that value. In our economy outside the corporation, price is established in the long run by competitive conditions at a level that allows a profit to both buyer and seller.

To achieve a counterpart within the new organization, each man or small team (partnership) should be a profit center and a decision point responsible for the success of those activities in which the center chooses to engage.

Much has been written about profit centers in the corporation. In the larger corporations, profit responsibility is often decentralized to divisional profit centers. Yet, even in the most extensive present use of the profit center concept, only a tiny percentage of the individuals in the organization are personally involved in a profit center frame of reference to guide their own decisions and actions.

The profit center concept is very different from the budget center concept which is so common in financial planning and control. In a budget center the individual governs himself relative to a negotiated expenditure rate. The objective within the budget center is often to negotiate the highest expenditure rate possible (because salary and status are associated with number of employees and size of budget) and then to spend the full budget. Indeed, there are often pressures to overspend because next year's budget is related to this year's expenditures. The budget measures performance in terms of cost compared to promised cost and not in terms of cost compared to accomplishment.

The budget system of control sets up two conflicting chains. On one side are the functional activities responsible for accomplishing the work of the corporation – research, engineering, production, and sales. In each of these functional areas are pressures to accomplish as much as possible, to hire as many people as possible, and to spend as much money as possible. Since these tendencies toward excess can not go unchecked, there must be an opposing group, such as the controller's office, to impress financial restraint on the first group. The resulting conflict between pressures toward excesses and restraint of those pressure can only be resolved at higher authoritarian levels in the corporation. Once a control system is established that is not based on self-restraint, the authoritarian structure becomes necessary to resolve conflict. Efficiency, motivation, and morale decline rapidly as the command channels become choked, and as the decision-making point becomes so remote from operations that first-hand knowledge is inadequate for sound decisions.

In contrast to a budget center, a profit center values activity and resources in terms of the difference (profit) between input costs and a sale price that is acceptable to others in a competitive market. The incentive is to maximize the difference between cost and value, to produce the most value for the least cost, and to reduce expenditure of time and resources where this can be done without a more than corresponding reduction in the value of the product. To be effective, rewards at the profit center, both financial and psychological rewards, must depend on profit and not on expenditure rate.

The way in which the profit accounting is done and the manner in which rewards depend on profit become of the utmost importance when these are the measures of success. The possible rules for this accounting cover a broad range. It is here that the self-interest of the individual is determined. It is in the profit center accounting rules that the individual meets the policy structure of the organization. It is here that individual self-interest and the objectives of the organization must coincide if a unity of purpose is to be sustained. It is here that the proper balance must be struck between long and short term objectives. It is here that the intended pressures must be created for adequate planning, for quality, for integrity, and for stability and growth of the organization as a whole.

The profit center provides the incentive to start new activity but, perhaps even more important, it must create pressures to discontinue old activities. Stopping an activity at the right time is one of the most important management functions. Too often, termination is delayed because it must be forced on an operational group having personal incentives to continue. In this conflict, termination can be imposed only when the external evidence for stopping the activity becomes overwhelming. Since emphasis should focus on the total life-cycle of an undertaking – successful beginning, successful mid-life management, and successful termination or transfer – profit center accounting for determining personal compensation should usually occur at the closing of an account and be measured against a compounded return-on investment basis that extends over the total life of the activity.

The detailed accounting procedures are beyond the scope of this paper. Initially the accounting rules can only be tentative because they will almost certainly need to be changed after observation of the pressures they create in the organization. Unintended pressures, or inadequacy of intended pressures must be corrected at their source by changing the accounting methods, not by building a body of compensating rules that would have to be implemented by a super-imposed authoritarian control structure.

In the profit center structure there will be similarities to the various legal entities in the outside economy. Some persons will offer personal services as advisors and consultants, others as contractors taking engineering and manufacturing commitments at a bid price, some as promoters and entrepreneurs to coordinate internal resources to meet the needs of the market, and still others in the role of informed investors to allocate the financial resources of the organization where the promise is greatest. Several procedures of the outside economy, such as the cost-reimbursement contract, which reduce the incentive for efficiency and tend to reimpose the budget method of control, would be prohibited.

Objective Determination of Compensation

If each profit center is designed to provide a sufficient measure of performance and if the centers correspond to individual people or small groups of people, then salary and bonus compensation can be determined automatically from the accounts of the center. Each man identified with the center would have a status similar to that of an owner-manager.

Above average performance, as shown in the profit center accounts, would lead to bonus payments, perhaps distributed into the future to give greater personal income continuity. If high performance persists, repetitive bonus payments would be the signal, according to a formula, for base salary increases to transfer more of the man's compensation to a stable income basis.

An " objective " determination of salary here means one that is not the subjective setting of one man's income by the judgment (often interpreted as whim or caprice) of a superior. Instead, income results from the value set on the man's contribution by peers who negotiate for his service. For this peer evaluation to produce more effective internal alignments, there must be enough internal mobility so that the man can find the more satisfying situations. He must have unhampered freedom to test the value of his contribution in a variety of competing outlets. The objective measure of value rests on the freedom to move away from any situation which he believes to result in an unfair evaluation of his worth.

Policy Making Separated from Decision Making

Policies and decisions are conceptually very distinct from one another although they are intermingled and confused in much of the management literature.

Policies are those rules that guide decisions. The policy treats the general case and at least partially defines how specific decisions under that policy are to be made. Conversely, a decision takes the status and information of the system and processes it in accordance with the guiding policy to determine current action.

In their effect on human initiative and innovation, four measures of policy are important – freedom, accessibility, source, and consistency :

By the first measure, policies can differ in freedom, that is, the extent to which they determine the encompassed decisions. A fully defining policy completely determines the decision as soon as the values of the input variables are available ; that is, when the existing conditions that are recognized by the policy have been measured, the rules of the policy are explicit and complete and the decision can be routinely computed. Such a policy leaves no freedom of action and can be automatized in a computer as are the policies for ordinary accounting procedures. On the other hand, a policy can establish a boundary within which the decisions must be made but with freedom remaining to adjust the decisions to personal preference or to information that was not foreseen by the policy.

By the second measure, policies can differ in accessibility, that is, the extent to which they are known to the decision maker. That decision maker is in a difficult and frustrating position who must act without being able to discover the policies which are to govern his actions. This inaccessibility of the guiding policies may arise for any number of reasons – the policies may exist but be undetectable, they may exist and be known but be subject to capricious change, or they may be nonexistent until a decision has been made which then may precipitate a contrary and retroactive policy.

By the third measure, policies can differ in source. Personal satisfaction with policies probably varies along the axis marked at one end by self-determined policies that govern one's own and others' decisions to, at the opposite extreme policies imposed by another who establishes those policies unilaterally for his own benefit. In a democracy, the source of policy is intermediate between these extremes, being established by compromise between the citizens in a search for the greatest average satisfaction.

By the fourth measure, policies can differ in consistency, that is, freedom from internal contradictions. Often one finds policy structures in which the parts are so fragmented and unrelated that the separate policies operate at cross purposes. Examples are seen in emphasis on ever-greater sales even with hesitance and conservatism in expanding productive capacity, in stress on quality and customer satisfaction even while overloading the organization till it can perform only poorly, and in the unresolved conflict between pressures for short-term success and long-term strength. Contradictory policy is apt to arise where policy is an interpretation of decisions rather than vice versa. When decisions are made on the basis of local expediencies and policy is formulated to fit, the policy structure becomes an assembly of unrelated pieces. If policy is to be internally self-supporting and consistent, it must reflect a systems awareness. Each part of the policy structure must be appropriate not only to its local objective but must interact with other policies in a manner consistent with the over-all objectives of the total system. In the complex feedback system structure of an economic enterprise, consistent policy can hardly be created in bits and by happenstance.

As measured along these four dimensions – freedom, accessibility, source, and consistency – policy often operates in a manner that is unfavorable to individual effectiveness. Policy is most suppressive of innovation when it completely defines action and states exactly what is to be done. Policy is most frustrating to initiative when it is undeterminable and subject to future definition and retroactive application. Policy is most antagonizing when it is imposed on a subordinate for the benefit of the superior. Policy is most confusing when it is internally inconsistent and provides no guide for resolving conflicting pressures. These undesirable extremes are closely approached in some corporations.

By contrast, the more successful corporations are characterized by policies that give coordination without confinement, clarity of forbidden action, objectives that balance the interests of all, and consistency that reduces unresolved conflict. Yet it would appear that only the rare corporation goes far enough in even one of these four measures of desirable policy and none go far enough in all.

Policy should allow freedom to innovate and should have the fewest restrictions compatible with the coordination needed to insure over-all system strength, stability, and growth. Policy should be accessible, clear, and not retroactive. The source of policy should be a process that ensures some consensus by those affected that it is a just compromise for the common good. Policies should be consistent by being designed as parts of a total policy structure that creates the desired dynamic behavior in the resulting system. Recent advances in the theory of dynamic systems and in system simulation using digital computers demonstrate that it will be possible to design internally consistent policy structures directly, rather than inferring corporate policy from the implications of past decisions.

Creating such a policy structure, and maintaining it as conditions change and new insights are acquired, would be a full time task for a small number of the most capable men in a corporation. The past and present of the corporate system must be studied as a background for designing policy changes which will create pressures and incentives toward an improving future.

Policy making ought to be separated from the distractions of operational decision making ; otherwise, short-term pressures will usurp time from policy creation, which can always be postponed to the future. Policy making ought to be separated from decision making to give a more objective and impartial outlook to policy design. Policy making ought to be separated from decision making so that the source of the policy is specific and responsibility for policy is clear.

Restructuring Through Electronic Data Processing

Vast amounts of electronic communication and computing equipment have already been installed for business data processing. Yet, the equipment is used almost entirely for tasks of the type that were previously done manually. Emphasis has been on doing more data processing within the earlier patterns, or on reducing the cost of work already being done.

The inadequacy of today's data processing objectives is exposed by industrial dynamics studies of corporate systems that show how behavior depends heavily on classes of information channels and decisions that are not today being supported by the electronic equipment. In these more important channels, information flow is haphazard, information is late, information is biased by human filtering, and error is frequent. Computers provide the incentive to explore the fundamental relationship between information and corporate success.

Part of the policy design task is to identify the relative importance of the various decision points and to determine the quality and fidelity needed in each information input. When this is done, information channels will be emphasized which are very different from those presently receiving attention.

Information networks can take several forms. The networks of most organizations are in the form of a complex mesh with many information repositories and large numbers of interconnecting channels. Another kind of network, made possible by the digital computer, takes the form of an information storage and computing hub with radiating spokes to each source or destination.

In the mesh network type of information system that is now common, the task of information storage and processing is subdivided to many small centers. Information is handled in batches, and files lag behind the status of the real-life system that they represent. Also, much of the information must be processed in series through several centers and there are large " inventories " of in-process information scattered throughout the system. Information retrieved from the system to guide decisions does not reflect past actions that are still being recorded and processed. This is often true even in the simple accounting and sales information that is now being handled by electronic computers. It is universally true and seriously detrimental in those informal information channels and decisions at the higher management levels. The mesh network becomes impossibly complex as the number of centers increases, particularly if each center is allowed to interact with every other center. A partial simplification has been achieved in practice by restricting communication channels to the inverted tree pattern of the formal organization chart. When this is done, lateral communication becomes slow and circuitous.

In the mesh network, substantial time and energy are consumed by internal communication that is made necessary by the dispersed storage of information. As a result, the organization becomes preoccupied with itself. It becomes inward looking with vast numbers of internal channels, the maintenance of which draws attention away from the contacts between the organization and the outside world. The organization consequently makes too little use of new technical knowledge ; it loses contact with new market trends ; and it is insufficiently aware of customer attitudes. These communication difficulties can be alleviated through a complete restructuring of the information system.

Modern electronic equipment permits a rearrangement of the information system into a radial or star shape with all files at the center. " On line " use of computers for both data processing and internal communication can provide an information picture that is up to date and fully processed at all times. Partially processed inventories of information can be substantially reduced, along with a reduction of the internal communication needed to estimate conditions that are not yet reflected in the formal data.

With such a restructured system, information will be directly accessible to persons that now must operate with too little information either to permit good management or to establish a feeling of security and confidence. If the internal information can be reduced, energy can be turned to the even more challenging quest for external information – information about new technical developments, new management methods, new employees, customer satisfaction, product preformance in the field, and changing markets.

Freedom of Access to Information

Much of the character and atmosphere of an organization can be deduced from the way it internally extends and withholds information. Corporations are almost all built on the authoritarian hierarchy structure but corporations differ greatly as to the basis on which authority and status are maintained within the hierarchy. In healthy organizations, authority tends to rest on generally recognized ability, ability which is great enough that it need not be excessively bolstered by information monopolies. In an authoritarian position that is not based on recognized ability, security may simply derive from the structure of the bureaucracy and the prerogatives of the office, or, position may be maintained by withholding information from both superiors and subordinates.

To possess information is to possess power. A monopoly of information can give a form of security. There are, in all organizations at all levels, a selective withholding and extending of information. Sole possession of information can make others dependent on oneself. Withholding of information can limit the scope and power of others' actions and reduce the threat to oneself. Control of information channels can isolate certain persons from the remainder of the organization and keep them within one's own sphere of influence.

Most persons in most organizations feel that they do not have access to all information they need. Sometimes they lack the information specifically needed to accomplish their duties. Very often they lack the information needed to create a sense of security and a belief in the fairness and rationality of the system of which they are a part.

Information is often withheld to forestall questions about an authoritarian decision that has no rational defense. The availability of salary information illustrates the point. Wages of workers in a union situation may be generally known because the contract rules have been made explicit ; information about individual compensation is made available to show that the rules are being followed. Conversely there are rules to justify the wage so that a subjective decision need not be defended. At the top of the hierarchy, executive salaries are published to stockholders along with information to implicitly or explicitly justify those salaries. In public service, salaries are set by law and are public knowledge. It is in the middle level of the corporation that one finds the greatest secrecy in salary details ; this middle level is where salary determination is most subjective and where a guiding policy is least available. One can generalize to the observation that the more obscure the reasons for a decision, the greater are the inclinations to hide both the decision and the information on which it was based.

An organization can be seriously handicapped by the loss of energy consumed in the struggle for information. Time is occupied by attempts to obtain and to hide information. Psychological energy is drained by the nagging belief that others are withholding information that one needs, and by concern lest others learn information that one hopes to withhold.

Just as the individual hoards information, so does the organization as a whole. Competitive position is often believed to rest on secrecy to a far greater extent than is the fact. Information is withheld from individuals inside the organization on the excuse that this keeps information from outsiders. Secrecy is a poor foundation for success compared with competence, and to maintain secrecy reduces competence.

Although one will never succeed in making all information fully available, the goal can be pursued. Access can be given to the information that is recorded in the formal data system of the corporation. Incentives, both the incentive of convenience and the incentives designed into the accounting system, can encourage the entry of information into the central data files, from which it can be electronically retrieved. Design studies of the corporate data system will show the importance of converting many of today's informal information channels to ones in which regular observations are measured and recorded.

A general principle of the new organization should be to give much wider and more ready access to information than is now the usual practice. This can be accomplished by reducing restrictions on information availability, by designing the social and incentive structure to favor the release of information, and to gather and record information in important channels that often remain on an informal basis.

Elimination of Internal Monopolies

On the national level monopolies are forbidden because of their stultifying influence on economic efficiency. Yet within corporations monopolies are often created in the name of presumed efficiency and are defended as avoiding duplication of effort.

For most activities the economies of scale are not as great as commonly supposed. In many situations where economy is expected from a larger activity it is easy to see that lower efficiency is, in fact, resulting. Very often the problems of planning and coordination rise so rapidly that they defeat the economies from larger size. This is particularly true of many of the service activities such as shops, drafting rooms, and purchasing offices.

Even where the activity itself may become more efficient in terms of local measures, the efficiency of the total organization may suffer. For example, in the consolidation of model shops, higher shop efficency may result from a greater load factor on machines and machinists. However, the consolidated shop, now administratively separated from the technical activities, is less responsive to need, requires negotiation of user priorities, and may well cost substantially in the valuable technical and management time of senior people on whom the success of the organization depends.

It should be a principle of the proposed organization that every type of activity and service must exist in multiple. No person is limited to a single source for his needs. No person is dependent on a single user of his output.

Only by eleminating the monopolies of the normal corporate structure can one have the efficiencies and incentives of a competitive system and provide objective and comparative measures of performance.

Balancing Reward and Risk

The new organization should retain and combine the advantages of earlier organizational forms while minimizing their disadvantages. One wishes to combine the stability and strength of the large, diversified business organization with the challenge and opportunity that the small company offers to its founder-managers. At the same time one must avoid the stifling bureaucracy and compartmentalization that is frequent in large organizations wherein the central power holds the right to allocate resources and make decisions. For the larger companies, competition exists on the outside but has no direct and often little indirect personal influence on those inside, except at the top levels of management. Conversely, the extreme risk and threat of failure in the small organization must be minimized since this repels many who might become effective independent managers.

In today's " small-business " world, the risk to the budding entrepreneur is greater than it need be. In general he gets but one chance. There is no opportunity to practice and to improve ability if the first undertaking is not a success. Penalty for failure should be reduced to a tolerable level but not eliminated. This can be done by risk sharing, not unlike the concept of insurance against catastrophe. The penalties should be just high enough to identify and dissuade the manager who repeatedly fails. Rewards should attract and encourage the competent and be high enough so that a normal quota of successes will more than carry the burden of occasional failures.

Offsetting part of the successes to cover the cost of the failures is now done by risk investors in the financial community but under circumstances unfavorable to the individual who seeks financial help. The investor is interested in a quick return on his investment. He has neither the skill nor the opportunity to substantially increase the ability of the new manager, or even to judge that ability in advance. The investor in new ventures is forced into a sorting process of trying prospective managers, staying with the successes, and dropping the failures as soon as they are so identified. Such a process must be contrasted with a more ideal one in which the individual grows from initially managing his own time, to managing small projects, to becoming an entrepreneur who matches customer needs to the abilities of the organization. This evolution without discontinuity from individual worker to entrepreneur can stop or be redirected at any point. At each stage a history of performance is available to the man and to his potential supporters as a basis for deciding the next stage of his growth.

It follows that specific undertakings must be small enough so that the total organization can survive any individual failure. A favorable over-all ratio of success to failure must rest on the greater efficiency instilled in the organization, the greater competence created by the internal educational system, and the personal growth induced by the freedom, competitive challenge, and greater opportunities for the individual.

Mobility of the Individual

In the new organization, in contrast to the conventional corporation, the individual should have much greater freedom of internal movement, and greater ease of voluntary exit, but more restraint on entry.

The non-authoritarian structure with its internal competitive characteristics lays the basis for internal mobility so that work relationships can continually change toward those that are more satisfying. This potential mobility must be made real by an educational system that prepares the man for new opportunities and by an accounting system that creates pressures to prevent reversion to the superior-subordinate relationship. The latter is one of the many pressures that must be created by the design of the data processing system. For example, mobility should be enhanced by limiting, in the profit center accounting, the credit allowed for income from any one source that exceeds a specified fraction of the year's activity. This would create pressures on each individual to maintain several activity contacts, making it easier for him to gradually shift toward the ones that are more desirable.

Most corporations have reward structures designed to discourage men from leaving. Pension funds and stock options have rules that penalize the manager who leaves before retirement age. The worker is under similar pressures generated by pension rights and union seniority.

The negative consequences of this mobility are serious to the health of the organization just as immobility can retard a country's economic growth. Dissatisfied persons, who therefore lack dedication to their work, stay in the organization rather than finding a position elsewhere to which they are better suited. The suppressed turnover rate in personnel makes it easy for management to ignore undesirable internal conditions which might be quickly corrected if they were emphasized by a higher personnel departure rate. Furthermore, we can assume that people who are unwillingly present are less likely to grow to greater competence and responsibility. Finally, the restrictions on leaving fail in their primary purpose by having little effect on the most competent men whose self-confidence and security lie in outstanding ability.

The new organization should hold people because they want to be a part of its kind of society. Any rights or deferred compensation that have been earned by past performance should be readily transportable if the man decides to leave. In fact, one might go further and visualize a placement office to assist any member of the organization in looking for a more attractive outside opportunity. If he finds one, the organization should reexamine itself to see if it is failing to offer the superior environment that is one of its principal objectives. If the man does not find the outside more attractive, he may become even more dedicated to the organization of which he is a part.

Mobility from the outside into the new organization is a different matter. Life in the organization would be very unlike most people's prior experience. The organization would be suitable for only a small fraction of them. It may well be that, if he has adequate information on which to base his dicision, a man can judge his own compatibility with the organization if he has adequate well be that, if he has adequate information on which to base his decision, a man can judge his own compatibility with the organization more accurately than those within can judge for him. The mutual decision by the applicant and the organization should be based on a far deeper acquaintanceship than precedes employment in most companies. This might be achieved through a series of study and discussion seminars that would expose the applicant, and perhaps his wife also, to the philosophy, history, psychological basis, objectives, and people of the organization.

The growth and stability of the total organization would depend on the mix of human resources and their rate of entry. The over-all policies must provide guidance and incentives for bringing in the proper skills. For this reason also, the inward mobility can not be as free as interior or outward mobility.

Enhanced Rights of the Individual

Thoughtful writers on the evolution of the corporation have raised challenging questions about the sources and legitimacy of corporate power and its effect on those involved. By law, power rests with the stockholders ; but in practice, stockholders have little control over either the acts or the selection of management. Considering the emerging concepts of social justice, there is serious doubt about the moral right of stockholders, acting through management, to the arbitrary power which can now be exercised over individual employees, particularly those in the middle management and technical groups. The precedents set in the last several hundred years by changes in the form of national government suggest that corporate power will also evolve from the authoritarian toward the constitutional. With this evolution, the primary objectives of the corporation would change from the already diluted idea of existence primarily for profit to the stockholders and toward the concept of a society primarily devoted to the interests of its participants.

The present day protection of the employee against the exercise of arbitrary power by the corporation is weak and unevenly distributed. Production workers, by joining together in unions, have won a few fundamental individual rights regarding seniority, grievance procedures, and rights of arbitration. But, as one moves up the corporate hierarchy, the subordinate has progressively less security against arbitrary decisions by the superior. It is in the technical and management levels, where initiative and innovation are so important, that we find most unrestrained that suppressor of initiative and innovation – capricious, arbitrary authority.

The new organization should develop around a " constitution " that establishes the rights of the individual and the limitation of the power of the organization over him. Corporate policy would be subject to corporate constitutional provisions just as the national constitution has supremacy over laws made by national legislative bodies. To complete the system, there must be means for " judicial review " by impartial tribunals to arbitrate disagreements and to interpret into illustrative precedent the operational meaning of the constitution and policies of the organization.

Education Within the Corporation

A modern national democracy rests on an extensive body of tradition and a high level of public education without which the democratic processes fail. This failure has been manifest in the turmoil during the formation of new nations. Without a foundation of education and tradition, premature democratic governments quickly revert to authoritarian regimes. By contrast, democracy in Western Europe and the United States now rests on a massive base of education and on deep traditions regarding the rights and responsibilities of the individual.

A corresponding foundation must support the new type of " industrial democracy " that is here being proposed. Such a base of education and tradition lies as far beyond the background possessed by today's average manager and engineer as the United States public background of democracy lies beyond that in the underdeveloped nations. The cycle of change can begin with education that guides practice which matures into different organizational traditions.

The more effective education of the future must permit man's transition to a new, higher level of abstraction in the economic process. The last such change in level of abstraction was man's entry during the last two centuries into our present industrial society. In the days of the craftsman, the most skilled in the population made the consumer products ; but, in the more abstract atmosphere of industrialization, the most skilled have become the inventors and designers who create machines that, in turn, make the consumer products. The skilled designers now operate once removed from direct production.

At the same time, the structure for decision making changed radically to one in which the decisions are now more abstract because they are removed from the point of actual production. The need for coordinating many efforts caused a sub-division and specialization of decision making, similar to the specialization that is so evident in actual manufacturing steps. Where the craftsman had hardly been aware of the distinction between deciding and doing, the industrial society separates the decision from the action. Decision making is separated from the worker because the governing policy is implicit and subjective. It has not yet been clearly stated. Coordination has been possible only by centralizing decision making in one individual so that consistency might then come from all decisions being tempered by the same subjective policies. But for this coordination we pay a high price in personal values and in flexibility to innovate and to respond to changing circumstances. The separation of work from decision making, with the authoritarian system that it implies, has been at the root of the growing dissatisfaction with the present trend in corporate government.

In leaving our present stage of economic evolution and moving to a future " automation society ", we must pass through another transition in man's relationship to production. In this still more abstract society, the most skilled, on whom the production processes depend, will be those who create the machines which in turn make production machines which, again in turn, produce goods. The most skilled will then be twice removed from actual production. This new complexity of industrialization has already begun.

The conceptual changes in management which must accompany our progress into the automation society are as sweeping as the change to centralized decision-making that came with industrialization. In the new phase there must be another restructuring of the decision-making process.

Our understanding of the industrial system is now reaching a point where the policy necessary to guide coordinated decisions can be made explicit and the policy structure itself can be objectively studied and designed. As this explicit treatment of policy is achieved, policy making and decision making can be completely separated. Policy making can then be executed by a central group ; and decision making, within the framework of the common policy, can be returned to the individual person.

In such a new industrial organization education must serve two purposes that are not essential in an authoritarian corporate government. First, understanding of the growth and stability dynamics that interrelate psychology, economic activity, and markets must be adequate to permit design of a governing policy structure. Second, the citizens of the new corporate society must understand the origin, meaning, and purposes of the policy structure well enough to successfully conduct their affairs in a manner that combines individual freedom with group coordination.

In preparing men for our present industrialized society we already devote a third of each lifetime to education. One might ask how a still higher level of education is to be achieved. There are several answers.

First, as we climb to the next level of conceptual abstraction, much of the earlier educational process condenses into a new, rational framework. Specifically, as we come to understand the fundamental structure and dynamics of social systems, we can learn explicitly and directly the general concepts which earlier had to be taught indirectly by historical incident or learned slowly from personal experience. Most present-day teaching in the humanities and in management is by the " case method " of retracing specific situations, leaving to the student the task of extracting some general principles from the apparently conflicting descriptions. Now, as it becomes possible to work directly with the pertinent system structures in the context of system theory and laboratory simulation, it becomes clearer how certain fundamental characteristics of social systems can produce the diverse modes of behavior that are observed. An understanding of social systems can be acquired much more rapidly if learning can be based on an explicit system rationale than if this rationale is only dimly and intuitively perceived.

Second, time for education can be obtained in the work environment if the confusions and distractions in present practice can be reduced by a clearer structure and a more efficient coordinating process. Estimates indicate that many of today's organizations consume 25 per cent or more of their potential effectiveness trying to coordinate internal activity. Much of this coordination is necessary simply because the organization is overloaded and trying to produce beyond its true capability. As the organization tries to do more in the short run, the costs rise rapidly in terms of confusion, coordinating and planning personnel, resolving priorities, and pacifying dissatisfied customers. The toll is especially high at the creative levels of management and engineering. Policies that ensure slight underloading could leave the same actual productive output and make the time now lost through attempted overloading available for a continuing educational program.

Third, time for education will be economically feasible if it results in greater long-term effectiveness. Greater revenue resulting from a higher degree of initiative and innovation can be allocated partly to the educational program. If the organization maintains its vitality and continues to change in keeping with the times, it should sustain a high enough level of contribution to society to justify a perpetual rebuilding of the educational base.

Fourth, education might be more effective if it could be properly coordinated with a man's development. This would require a true educational opportunity as a continuing part of work environment. Then it would be possible to shorten a man's formal education at the college level and defer the study of many areas until work experience has indicated their importance and until learning motivation is higher. For example, engineers early see the importance of science but they may be well launched on their professional careers before they see reason to understand psychology, the dynamics of industrial systems, law or even effective writing.

What, then, should be the place of education in the corporate strategy ? The arguments are persuasive that some 25 per cent of the total working time of all persons in the corporation should be devoted to preparation for their future roles. This means time devoted to competence some five years in the future and does not include the learning that may be a necessary part of the immediate task. Over a period of years this study would cover a wide range – individual and group psychology, writing, speaking, law, dynamics of industrial behavior, corporate policy design, advances in science and engineering, and historical development of political and corporate organizations – the extent and sequence being tailored to the individual person.

Such an educational program would differ substantially from any now offered. It must be derived from the same foundations and social trends as the new corporation itself. It must be at the same time more practical, but also more fundamental and enduring, than existing advanced training programs in either technology or management.

The educational program must become an integral part of corporate life, not a few weeks or months once in a lifetime at another institution. The overall policies of the organization must create incentives that protect the time for education from encroachment by short-term pressures. Because self-development is so easy to defer, the responsibility for personal growth should probably be shared by the individual and a " career advisor " whose own compensation depends on the growth and success of his protégés.

ANALOGY TO NATIONAL ECONOMIC STRUCTURE

The central feature of today's corporation is its authoritarian power structure, with the superior-subordinate pair relationship as the fundamental building block. Ultimate authority for all decisions lies at the top and this authority is delegated or withheld by the superior at each level. So entrenched in our thinking is this authoritarian structure that few people can visualize an alternative, yet our largest economic unit stands as a striking and successful contradiction.

The growth and strength of the United States as a whole rests on an economic structure in which the superior-subordinate relationship is absent. Legal entities, be they corporations or individuals, are related to each other as equals. Corporations, doctors, lawyers, shop owners, independent contractors, and private businessmen interact with one another in a structure based on self-interest, not on the right of one to dictate to another. The United States' economic structure is not an exact pattern for the new organization. Yet the constitution and legal structure of the country offer many clues to answering the more difficult questions about the proposed organization.

The profit center concept of the proposed organization brings into the corporation the same free-enterprise profit motive that we believe is essential to the capitalist economy. The objective determination of compensation is the same process that determines the profitability of legal entities in the outside economy.

The stress on separation between policy making and decision making has its counterpart in the separation, on the one hand, between congressional and executive branches of the government and, on the other hand, between the policies set by law and the decision-making freedom left to the independent economic units. Laws, viewed as policy to govern economic activity, tend to be boundary policy stating what can not be done and leaving all else to the discretion of business decision makers. The counterpart of laws would be corporate policy designed to achieve adequate coordination while permitting individual freedom.

Freedom of access to information within the corporation has its equivalent in the freedom of the press.

Anti-monopoly legislation rests on reasons that should prevail far oftener when corporations decide whether or not to combine similar functions.

Education as a major function of government has an equivalent in the emphasis that the corporation should place on preparing its people for the future.

IMPLEMENTATION OF THESE PROPOSALS

It is not implied that these ideas for a new corporate design are yet developed to a point where they would fit all types of businesses. But they do seem particularly suited to those industries which feel the impact of rapid change in science and technology and in which conventional management approaches have often been found wanting.

An experiment in organization should presume slow growth at first under conditions permitting revision because it must be realized that an enterprise as different as the one here proposed must test and evolve its most fundamental concepts as well as their implementation.

It does not seem likely that such sweeping changes could be implemented by gradual change within an existing organization. The new proposals represent a consistent structure ; but they contain many reversals of existing practice. Introducing the changes piecemeal would place them in conflicting and incompatible environments ; the changes would be contrary to existing traditions and would give rise to counterpressures high enough to defeat them.

The only promising approach seems to be to build a new organization from the ground up in the new pattern. It might be either a truly new and independent organization or a detached and isolated subsidiary of an existing corporation. It must feel its way, modify ideas where necessary, and create success at each stage as a foundation for further growth.

REDESIGNING SOCIAL SYSTEMS

A Note on Bureaucracy, Creative Federation, Business and the War on Poverty in the United States.

by

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1. INTRODUCTION

As the policies and programs of the Government of the United States attempt increasingly to achieve major social objectives, it is becoming increasingly clear that the quality of administration of these policies and programs plays a major role in their effectiveness. For many programs, a lack of effectiveness can be attributed at least in part to inefficient administration.

Given this fact of current political life, what can be done about it? Two solutions have been proposed, neither very satisfactory. One suggestion is simply to abandon the goals. This is fine for those who do not subscribe to social goals such as the elimination of poverty; for those who hold such objectives to be outside the proper scope for federal action. But there may be those who favor abandoning such goals not because they find them improper as goals but because they believe them to be unachievable – for reasons of bad administration among others. This paper argues, however, that they are achievable, and that goals such as the abolition of poverty should not be abandoned by those who find them desirable.

The second suggested solution to the obstacles to achievement of social goals caused by bad administration is to improve the administration. But we have been trying for years to improve administration of programs, and although advances have been made and more advances are possible, it seems now that new goals and programs are proliferating far faster than improvements in administrative systems. Even more important they are proliferating far faster than competent administrators and planners.

The course of action suggested here, therefore, is neither to abandon the goals nor to depend on greatly improved administration to achieve them. Rather, it is to attempt these goals by designing systems which are less sensitive to bad administration – systems which are likely to work well even with imperfect planning and management techniques and shortages of planners and managers.

The obvious problems of federal administration have provided one reason for the increasing pressure to turn over more of the War on Poverty and other Great Society programs to private business and to the states. There is a feeling that Somehow there is more efficiency inherent in these non-federal organizations. To some extent, this is true, for two reasons:

First, that decentralized operations move the locus of decision–making down closer to the locus of the application of the decisions. This implies that the decisions will be based on better and more detailed information and be more applicable to particular conditions and cases. The importance of this factor should not be overplayed, however. It does not take reliance on business or the states to decentralize decision-making. Many existing federal programs run directly to localities, and the Community Action Program sets up special local decision-making organs for its purposes. And in any case, some of the worst bureaucratic systems have the most decentralized decision-making. A major problem with the Public Assistance structure of the United States, for example, is that decisions are made by the caseworker, case by case.

The second factor, then, may be more important than the first. The key may be not decentralization as such, but the design of a system in which people make decisions for themselves in their own best interests, but the sum total comes out in the direction of the social good – Adam Smith's "invisible hand". Not only can such a system be relatively efficient, but decision-making for oneself is a lot more palatable than having decisions made elsewhere. And if incentives or rules can be designed to induce the many prime movers in business, the states, and the localities to move in the same socially desirable direction at the same time, then the power of this movement can exceed the power of the federal government to accomplish the same ends directly. The fact that the economic system of the United States has depended upon general incentives moving such masses of business and other decisions in the same direction is one of the major reasons for the general economic success of the United States. Many prime movers are induced by the profit incentive to move in a direction which favors the social good, rather than a few prime movers making decisions to be applied in detail to others through large administrative systems.

The utilization of incentives to business as part of a general system of living with bad administration forms a major portion of this note. It is less clear, however, that such a system should include a major shift of decision–making from the federal government to the states. There is certainly little evidence thus far that this form of decentralization is efficient; and if the crucial factor is incentives rather than decentralization as such, the applicability to the states may be limited.

There are several obvious obstacles to state efficiency. One, which is rapidly disappearing, is the malapportionment of many state legislatures.

More fundamental, however, is the difficulty always encountered thus far in getting states to go along voluntarily with policy determined by a national majority. The Southern states and desegregation provide the obvious example here, but not the only one. National policy dictates that the billion dollars dispensed annually under Title I of the Elementary and Secondary Education Act go to deprived children and schools; this is not always the case in some good liberal Northern states. For this reason, it is possible to be a bit skeptical of unconditional Federal grants as a major solution to problems other than the fact that the states have insufficient resources.

Block grants federal funds, giving the states wide discretion so long as they use the money for designated purposes, may be preferable, and it is suggested below that block grants of the Title I type do have a role in many social programs. But block grants for purposes as broad as getting rid of poverty, for example, will be relatively ineffective in states which are not terribly interested in getting rid of poverty – by and large the poorest states. And trying to devise incentive systems for states has thus far ended up in the current maze of federal grant procedures, which does not seem a strong alternative. What it comes down to is that we understand considerably more about the monetary profit motive which (by and large) moves business than we do about the political power motives which move state governments. And without understanding them, it is difficult to use them for the common national good.

2. EXAMPLES AND RULES

To caracterize further the differences between the more and the less administrative approaches to Great Society programs, both approaches require national planning, in the sense of prediction of the future results of current policy decisions, and the design of current policy to achieve the future results. But beyond this they diverge. They diverge in the type of planning, level of planning, and detail of planning which must be done, and they diverge perhaps more importantly in the way in which these plans must be administered and executed in order to succeed.

The type of planning which can be associated with a highly administrative approach is one in which programs must be planned in detail at every level. A master plan sets forth the general types and levels of programs, the master plan must be supplemented at the central level by detailed subordinate plans, and the detailed subordinate plans must be supplemented by other plans at the operating level – in industries, plants, states, cities, school districts, local communities, subcommunities, etc., as appropriate. These plans at each level must be coordinated to make sure they are consistent with one another and with the conditions imposed by external reality. Furthermore, in order for them to operate toward a desired objective, their execution – the carrying out of plans – must be in accordance with these plans and must be even more highly coordinated. A few errors in plans or in their execution can quite possibly turn the results of the plans in a direction opposite to expectations. All this takes many planners — probably more than are available, certainly far more than can be used economically, given other demands on planning capabilities.

The sort of planning associated with the less administrative approach is quite different. It sets general rules to guide decisions in general directions, and then counts on existing "natural" economic and social forces to execute these rules. It uses such things as market conditions, incentives, and bargaining power for its achievement, and it tries to structure these factors so that the achievements are the desired ones.

On the level of execution, the two approaches are also substantially different. Associated with the approach which uses detailed planning at every level is an attempt to administer such plans by the use of substantial interpretation and personal discretion by the administrators. To operate the detailed plans (which cannot possibly cover by written regulations most specific cases) a large number of administrators must apply the plans to these cases. Naturally, different administrators will interpret things differently and their various decisions will clash and frequently cancel out. Even more important, this detailed administration by people on people is subject to the intentional and unintentional abuse which characterizes, for example, the Public Assistance System. In contrast, the less administrative approach, rather than requiring detailed interpretation and administration of specific rules, allows individual operators to act in their own interest, and by a proper set of incentives guides this interest toward the desired social good.

And, by and large, those programs which have stressed detailed planning and administration have historically either not worked or worked only on a scale which was very small compared to the size of the problem. In order to make them work aat all it had been necessary to keep the scale small in order to oversee the details of administration. By contrast, history shows that programs stressing the more general approach have worked far better. Consider the following examples of the highly administrative approach.

- *The National Recovery Administration.* Probably the most detailed and comprehensive attempt to make the economy work by detailed plans and rules was the NRA of the first New Deal. Under the NRA, each of the industries of the United States was to prepare detailed structural, operating, and pricing plans to be ratified by the Federal Government, which were then to be followed in detail by the industries in question. The NRA had many ramifications, not all of which are relevant here, but the point is that it was designed to substitute for the use of the market a highly detailed set of rules by which goods and services would be produced. Until NRA was declared unconstitutional in 1935, it attempted to do just that – with a very mixed record of success and failure. It did not work very well. Its major permanent impact on American economic and social policy was Section 7A, on collective bargaining, which was translated into the National Labor Relations Act, and effected fundamental change by changing the rules – not by careful administration.

- *Price control and rationing.* These devices during the second World War undoubtedly did keep price levels below where they would otherwise have been (given the other policies of the time) but the exigencies of detailed administration allowed substantial inflation anyhow, and encouraged such abuse that the whole system became completely unworkable after the end of the cooperative spirit of the war.

- *War Labor Board and Wage Stabilization Board.* The same statements as applied to price control and rationing can be applied to these.

- *Public Assistance.* Public Assistance, which started out with high hopes of designing aid to fit individual needs in the 1930's has become a brutal system of degrading investigation and big brotherism, as well–meaning social workers have tried to apply detailed rules to individual cases.

- *Public Housing.* Public housing has created and perpetuated ghettoes, while replacing old slums with new ones. The major reason for this is that the designers of public housing would not and could not think through all the implications of their carefully planned ideas. The same is even more true of urban renewal as a device for improving low income housing although it should be noted that improvement of low income housing is not its sole purpose.

- *MDTA Training.* MDTA Training has worked in many cases to retrain those affected by structural economic change and in fewer cases to give initial training to those needing basic skills. But because it has depended on a detailed system of negotiating the setting up of institutional courses and OJT slots, it has had to remain quite small relative to the needs. There are simply not enough administrators to get going the number of individual small projects which would start to reach a major portion of those in greatest need with the types of programs they need.

By contrast the examples we have of the less administrative approach – the setting of general rules within which people can move freely in their own interest – show substantially more success. For example:

- There can be little doubt that the sophisticated use of fiscal policy and monetary policy in promoting general prosperity and in ironing out economic fluctuations has worked far better than the price-control/wage-control/rationing systems of wartime. By controlling the total demands on the economy, but allowing millions of individual self-interest decisions to allocate the demand and supplies under these general controls, fiscal and monetary policy have been able to combine a high degree of prosperity with sufficient price stability.

- The income tax system, with all its loopholes and abuses, has proved an effective way of collecting revenue by setting general rules and allowing people to apply them to themselves. To the extent that the system has not worked, this has been largely because of many specific exceptions written into the law which have changed some parts of it, particularly for higher incomes, toward an administered system. It should be noted that one feature of the income tax law is enforcement "by exception" – that is, negative enforcement looking for abuses, rather than positive enforcement trying to apply the rules administratively and precisely to each case. The income tax system shines particularly in contrast to the local property tax systems throughout the country which have depended upon detailed administration – individual assessment by external authority – and which have been badly abused and have provided insufficient revenues.

- The Social Security System, setting up a relatively simple set of rules for self-application, has shone indeed by contrast with Public Assistance.

- Finally, one case exists which illustrates either the difficulties of the more administrative approach or the advantages of the less administrative, depending upon what one considers its major objective. The Wagner National Labor Relations Act of 1936 set up an administrative system to enforce industrial justice. This worked moderately well, but was subject to substantial abuse, which caused many people to claim that it brought injustice rather than justice. As a result, it was drastically amended by the Taft-Hartley Act of 1948 which complicated the administrative system considerably, and was probably subject to more abuse. As a case in jurisprudence, it is doubtful whether either Act can be considered a model. If the real objective of both of these laws was not justice as such, however, but basic economic and social restructuring through a change in the balance of bargaining power, they both worked very well indeed. The Wagner Act set some rules and changed some relationships which made possible the growth of mass labor unionism in the United States. It thus changed the entire economic and political structure of the country by setting conditions which made it possible for workers to bargain by themselves, *rather than by trying to dictate the results of those bargains.* The Taft-Hartley Act changed the bargaining balance part of the way back again, and regardless of the justice or injustice of particular provisions, achieved what seems to have been the desired effect on the power balance. *As administrative attempts to deliver justice, the two laws were mixed in their effects; as attempts to change the structure of the United States by changing the rule of bargaining in the marketplace, they were outstandingly successful.*

These contrasting sets of examples argue strongly and pragmatically for the more general approach. In general, it works; in general, the detailed administrative approach does not. The reasons for this seem clear enough – they start with the impossibility of writing detailed rules to fit every case, and they end with the lack of highly trained people to administer every case. The reasons have to do with the fact that detailed discretionary application is generally obnoxious to the American ethos; they have to do with the fact that an army of administrators and enforcers is an economic waste if other devices can be found.

Some counterarguments should not be ignored, however. The less administrative approach will have visible "wastage" associated with it, general rules can miss specific cases and thus can cause abuse. (But trying to set rules for every specific case leads to administrative discretion of the Public Assistance type.) Some examples of this wastage can be given. I have been told that the only really successful housing program for low income people took place in the late 1940's when money was given out to builders under a loose set of rules. The system was abused for private profit and because of this abuse it was ended, but it built houses. Indeed, a larger and older example of the same thing comes from the land grant system of encouraging railroad building in the last half of the nineteenth century. Huge profits were made at the public expense but the railroads were built. Applying this to current problems, one argument against programs of general income maintenance under simple rules is that some people will "abuse" the system by sitting on their porches and living on the dole when they "should" be working. And they will. The question is whether these abuses are more or less tolerable than the only alternative – a system of detailed investigation of the Public Assistance type.

In any case, let us consider the characteristics of a non-administrative approach to current problems. The first of these is that the approach and the rules set up under the approach must indeed be general and work by guiding self-interest in a socially desirable direction. Under this statement can be listed several subprinciples:

1. Processes should be wholesale rather than retail. By this is meant that the processes set up should be general systems, and that public administrators should avoid trying to set up many small carefully designed programs under such processes. Rather, individual "operators" should be encouraged to set up programs which conform to the general rules.

2. In order to do this, the processes themselves must provide incentives for large numbers of operators to set up individual programs in their own self-interest. Indeed, such incentives for individuals to do voluntarily what is socially desirable is at the core of any general system. An opportunity for a million people to profit by doing what we want them to do is likely to work much more smoothly than an attempt to set the rules for a million individualized publicly sponsored programs.

3. This means that these incentives should work largely through the private market. It does not mean that business is in some sense superior to public officialdom, but it does mean that the market processes themselves require less capability and less morality to work in the right direction than does a process in which every rule must be carefully designed.

4. Market processes in this sense need not be confined to the competitive market of classical economics. The concept of the market here is a broad one which includes the bargaining markets discussed by Galbraith as well as the trading markets discussed in standard economic texts. A very powerful tool which can be used by government is to set up conditions which strengthen the bargaining power of those whose power needs strengthening. This was the point of the Wagner and Taft-Hartley Acts.

Under the general characteristics described above, there will, of course, have to be rules — albeit — general ones. These rules also can be described:

1. They should be, insofar as is possible, self-applied rules. That is, as in the income tax system, they should be set up in a way which makes it reasonable to expect that people will apply these rules to themselves. One necessary characteristic here is that the rules be simple enough for people to apply themselves. There is no doubt that self-applied rules are subject

to abuse; the self-employed evade taxes more frequently than do those whose income is withheld by their employers. There is no doubt that some people would abuse an affidavit system of qualifying for public welfare but the alternative is welfare investigations. Just as a certain amount of tax evasion is inevitable and we manage to live with it, a certain amount of other abuse is inevitable but can be lived with.

2. In order to keep abuse down, the general rules will have to be enforced but they can be enforced as the tax rules are, by exception. That is, the accepted norm should be compliance and a search for non-compliance should be on a sample basis. Together with strong penalties for non-compliance, such a system keeps the tax system workable even though abused.

3. Associated with the above is the fact that rules are much more workable if they are of the "don't" variety than if they are of the "do" variety. People in this country find far more tolerable limits on their actions than they do specific directions about what they should do. An example here – a perverse one – is the recent political failure of most open housing laws. Although these laws are essentially of the "don't" variety, the campaigns against them have been cleverly designed to make them appear as "do" laws. The anti-open housing campaigns have contended that such laws would force people to sell or rent homes to others chosen by the government. This charge is phoney – the laws are "don't" laws preventing a certain kind of behavior rather than directing another kind – but the proponents of open housing have not been able to make this clear.

Finally, an additional characteristic of a general system is that where sophisticated and detailed rules which are exceptions to the above descriptions are necessary, these sophisticated rules should be designed to apply to a small group of controlling interests, rather than to the populace at large. For example, monetary policy as it affects the general public and economy is a prime example for a general system which works on people's individual decisions in their own interest. Monetary policy, however, does depend in part upon a detailed and sophisticated set of rules applied to a sophisticated set of people, bankers. Other strategic groups can be singled out for detailed application of rules where necessary but this should be the exception rather than the general rule.

3. THE WAR ON POVERTY

It is possible, using the above description of a general program, to design a somewhat changed War on Poverty, which builds on some of the lessons from existing programs. The set-backs of the War on Poverty to date have been largely associated with the difficulties of applying a specific and administered program to more than 30 million poor individuals. The resources in terms of welfare workers, teachers, trainers, community organizers and so forth have not been there to make a detailed program work well, and it could be argued that a much more heavily funded program of the current type would have run into even more trouble for this reason.

This is not to argue against more heavily funded programs of the current type. Indeed, were it possible, the preferred alternative might well be to continue what we are doing, but with more money – much more, beyond any current wild dreams. Paradoxical as it might seem,heavy funding could change a more administrative one. With enough money, it would be less necessary to pick and choose in detail among programs, among communities and among individuals. If enough money is spent, the lack of personnel and the difficulties of detailed administration would cause the program to shoot off in all directions, most of them wrong, but with enough money, a lot of it would inevitably go in the right direction. And although the " waste " would have been very large, the non-wasted funds would still be large enough to approach the desired objective.

This is the story of American defense policy. The Department of Defense follow in general all the detailed methods decried above, but it pours into national defense such incredibly large amounts of money that we have sufficient defense and military strength to accomplish any purpose which can be accomplished by military power. What if billions are wasted by the standards applied to the War on Poverty; the remaining billions still buy an awful lot of defense.

But under the reasonable assumption that there will never be as much money for a War on Poverty as we have for other wars, what kind of general program might work in the poverty area?

What is suggested below is not a stark contrast to current programs. Rather, it moves toward the less administrative end of the continuum from the more administrative end, diluting the mixture with broad measures, wherever possible.

It begins not with a specific service-providing program, but with a specific application of a general principle relevant to any program bearing on poverty. Public decisions in the United States, whether federal, state, or local, are arrived at in large measure by a political bargaining process. He who has an ability to apply pressure has an ability to effect a decision. And one reason for the past lack of services of all sorts to the poor has been their weakness in this bargaining process. The poor have not been felt in the education process, therefore poverty-area schools have been treated poorly, the poor have not been felt in legal circles, therefore justice for the poor has been unequal, and so forth. Typically, until recently, the bargaining constituencies of any government agency consisted of its clientele and its own bureaucracy. Since the poor were not the major clientele of any agency except welfare – and they have a powerless clientele there – their bargaining power has been negligible. The creation of an independent anti-poverty agency, the Office of Economic Opportunity, and the Community Action Agencies which are its analogs at the local level has begun to change this situation. An independent agency, with the poor as its sole clientele, and with a bureaucracy which is still relatively new and idealistic, is a *sine qua non* of an effective war on poverty. Hopefully, as the bureaucracy hardens with age (as it inevitably will) the bargaining power of the clientele – the poor themselves – will increase to the point where the additional bargaining power of the new bureaucracy will not be necessary. Until that time – and it has not yet been reached – independent poverty agencies at the national and at the local levels, with their independence maintained through independent sources of funding, are essential.

The service-delivery programs of the War on Poverty can be divided into four major categories: Job programs, individual improvement programs, primarily of the educational type; community betterment programs, and income maintenance.

A. Jobs. Instead of an overall job program depending upon specific small-scale training projects which are never likely to reach a wholesale level capable of really getting to the bulk of those in need, we might suggest a general process of encouraging business to train the poor and of encouraging the poor to obtain jobs.

A. 1. A tight economy, tight enough for jobs to be available for anyone with a decent level of skill, living in the right place, is a *sine qua none* in the job category of this program just as it is under any kind of War on Poverty program.

A.2. Instead of training of the many types going on now, none of which reaches the poor sufficiently, the job program would give business a substantial *subsidy for training the poor.* This subsidy could be of a tax rebate type or the direct subsidy type but it would work on a general basis with sufficient money being handed over to business for each under-privileged trainee to make training a profitable operation for business. Such programs have been rejected in the past because they were subject to abuse and because in addition to subsidizing training they would also be a direct subsidy to business. These charges are true, nonetheless such a subsidy available to all business-men big and little seems the only way to provide enough training effectively to reach the population in need. The subsidy should be confined to trainees who declare themselves poor by affidavit, who have bad employment records, or who otherwise can be identified by a simple system, thus distinguishing it from current proposals to subsidize training in general through a tax credit. Such proposals could subsidize much training which would be done in any case, increase the total of all training moderately, and do very little for the poor. A specific and interesting variation on the training subsidy theme, however, might be a training insurance program, insuring those firms who train the poor against losses due to turnover of trainees before the company has had its training investment returned.

A.3. *A general mobility subsidy* should be made available to anyone moving to take a new job. Rather than the current types of mobility programs, which use a social-work approach – taking someone in a depressed area by the hand and leading him to a skill shortage area, – these would be simple but substantial money allowances to movers. Money would inevitably be provided to those who don't need it and who would have moved anyway but the alternatives are either the program remaining far too small or a vast bureaucratic and administrated program. A tax credit – positive or negative income taxes – might be workable here too. Indeed, such a credit already exists in the positive income tax, but of course it does not reach poor non-tax payers.

A.4. Parallel to the mobility allowances would be *locational subsidies for business* – incentives to put plants in rural depressed areas or in urban slum areas. Coupled with the training subsidies mentioned above, these might be very powerful programs to create jobs for the poor.

A.5. *A low-wage public employment program* for those who could not get jobs any other way would complete the employment portion of the package. The low wage would tend to insure that those with better opportunity would not simply fall into public employment, but the program itself is necessary because it must be realized that a substantial portion of the hard-core poor are not likely to be able to get jobs in the competitive market *even after absorbing all the training they can.* A low-wage public job is a preferable alternative to income maintenance to those who can work and need work for their own self-respect. Several years ago, such a public employment program was proposed, and since then, the proposal has developed in a way which is illustrative of the relationship between the more and less administrative approaches. The initial proposal was a simple one, definitely on the less administrative side of the spectrum. It suggested funding public and non-profit institutions such as schools and hospitals to hire the poor. Objections to the scheme centered around the contention that it was "dead-end" job creation, lacking training, etc. The cogency of these objections increased as, in the time period following the initial proposal, the national unemployment rate dropped sharply. As a result, it became close to true that a job was available for a trained person, and training became the central thrust, rather than job creation as was the case when the initial proposal was made. As a result of this, the proposal developed from public employment to "work-training" and from a simple device for residual job creation to a highly planned, structured, and administered program. It has been adopted; predictably it will run into administrative difficulties. And there remains a need for a public employment program of the original type for those who cannot be readily trained even for a tight labor market.

A good deal is contained in this five-point approach to jobs, a reasonable question is: what is omitted as being too administrative? The omissions are substantial. Recognizing that what we are talking about here is phasedown of old administrative programs in favor of new simpler schemes, not instantaneous changeover, the omissions involve all public job-training programs except for vocational schools and rehabilitation for the handicapped — in other words, all public *antipoverty training programs.* Thus the omissions (or phasedowns) include institutional training which typically has done little for the poor, on-the-job training contracts laboriously negotiated employer by employer, with the employers refusing to hire the hard core in any case, special programs designed down to a level of detail which guarantees their unworkability on a large scale; and, in general, programs which take a wealth of administrative, instructional, and counselling personnel who are simply not going to be available on the needed scale. Substituted for all this would be the broad program of incentives for training, mobility, and business location; and public jobs for those who cannot be brought into the private market by these incentives.

The one sort of detailed administered program which might continue to be a part of the package could be a small-scale high-quality program such as the Job Corps, which has now been shown, by benefit-cost analysis, to be such a program. By keeping it small-scale, many of the administrative difficulties can be avoided, and directing such a program at a small but crucial target group at a key age (the male target population for Job Corps is only about 200,000 at any given time), may justify it.

B. *Individual Improvement – Education.* What is needed here is a recognition that we do not really know all the specific programs that are needed by the poor to compensate educationally for all their other disadvantages. This is not to say that we should not continue to experiment, but that the payoff on experimentation, demonstration, and spreading specific techniques throughout the educational system is likely to be very long in coming. As the result of this, two general programs are suggested.

B.1. A substantial *expansion of the general funding approach typified by Title I of the Elementary and Secondary Education Act,* and the eventual inclusion in this approach of all pre-school programs. The point here is that most school systems need much more money to do anything for the underprivileged and until we know precisely what to do for them, more money – targeted by law on the deprived and other than becoming general aid to education, which will leave the poor, as always, last in line – is going to help. A lot of things to be done may be obvious ones – teacher training for example – and some of them may be fruitless, but many are likely to work. Indeed maybe the real payoff here can come from a generalized Hawthorne (1) effect where schools, children, teachers all improve because they know the nation as a whole is interested and committed.

B.2. Parallel to this in the higher education field would be a *GI Bill type of scholarship program.* Perhaps unlike the GI Bill, this would have to be income tested but in any case it should apply to all of the eligible who are capable of getting into any college or advanced training.

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(1) In the Western Electric plant in Hawthorne, Indians, a study was conducted in the 1920's to discover the effects of lighting on the productivity of young women doing assembly work. The lighting was improved; productivity rose. It was worsened; productivity rose again. It was changed in various ways; productivity rose. It was finally concluded that the young ladies were producing more because people were paying attention to them.

The major change here, then, is in the de-emphasis of the search for the "right" educational program which will by itself solve all the educational deficiences of the poor. Rather the approach admits that we know little or nothing about the anti-poverty effectiveness of educational alternatives in the vast variety of existing school situations, but that we do know that in any situation, more money is better than less, and more attention to the kids is better than less. We do not abandon evaluation of alternatives, but we do abandon an immediate hope of finding the magic solution. And we abandon the effort to direct the moneys in the precisely right direction, concentrating instead on the difficult enough task of directing them at the poor. ("Shouldn't Head Start be for the poor in spirit as well? ").

C. The *Community Improvement* portion of the program would have a number of varying aspects:

C.1. In the *housing* field, there are two objectives. The first is to provide much more and better housing, the second is to provide much more desegregation. The first objective should be achieved by an incentive to private business (profit-making business) to build better housing for the poor. There is no doubt that some level of incentive payment will encourage the desired program and there is no reason we should shy away from private businesses making an honest dollar out of it. Desegregation is necessary to success in a War on Poverty and may be the single hardest thing we have to do. There can be little doubt that compulsory open housing, even though it is enforced by exception, has come to a political standstill. We should still push for open housing laws, but we should recognize that they seem unlikely in the near future. What can be done in the interim are two things. First we should push very hard for voluntary open housing and this may not be a completely lost cause. Nonetheless a voluntary open housing program equally is least likely to succeed in the areas of greatest need. A second measure which should be undertaken, and perhaps can be in the shorter run, is a set of regulations enforcing open housing on realtors and commercial sellers or renters of housing. There is no telling, in this country, how much segregation is due to individuals who are afraid of desegregation and how much is due to realtors enforcing "existing patterns." My feeling is that a good deal is due to real estate practices. There is little doubt that in some districts of Chicago segregation is almost the unanimous desire of the residents, but outside of districts such as this there is a substantial likelihood that many individuals would be willing to rent or sell homes voluntarily on an open basis if the real estate man would just bring around someone of a different race. Realtors don't, but perhaps they could be made to. There seems no reason why fairly strict laws could not be applied to realtors forcing them to list, sell, and rent housing on an open basis except where the individual selling or renting expresses a desire otherwise. By putting the burden on the individual wanting to segregate by forcing realtors to go along with this we might achieve a pattern quite different from that encountered in a system which puts a heavy burden on the individual choosing to desegregate. To attack on the realtor would be an example of a sophisticated measure applied to a small group of controlling interests, rather than a measure which we try to apply and by discretion to the entire population. This approach to housing for the poor, and to desegregation, would substitute for massive public housing projects – which have not worked well in providing decent housing and not at all in desegregation; for urban renewal and detailed "planned growth" – which still seems to mean Negro removal, and for the new movement for "private" nonprofit housing for the poor – which could well combine the faults of public housing projects and small-scale operations with the lack of incentives associated with the word "nonprofit". Such a local "nonprofit" operation, however, might at least provide some low-income housing, which may make it preferable to the national "Comsat" housing corporation sometimes proposed, which seems to combine lack of identifiable function with accretion of private power politically responsible to no one. Such corporations epitomize an emphasis on the mystique of private enterprise efficiency together with an ignoring of the fuel of private enterprise – profits.

C.2. A major part of the War on Poverty has been and should continue to be the *creation of community institutions in poor communities,* with an ultimate view toward creating political self consciousness on the part of poor communities, and thus political change. A continued and expanded neighborhood center program could do two things here. By bringing people in and bringing services in as much as possible, it could create the nodes around which community institutions now lacking could build themselves. This could be a social process somewhat parallel to that built around the settlement houses, workers alliances, churches, and saloons in historical slums. Once these institutions started to build, they could achieve political power for slum commu-

poor communities, and thus political change. A continued and expanded neighborhood center program could do two things here. By bringing people in and bringing services in as much as possible, it could create the nodes around which community institutions now lacking could build themselves. This could be a social process somewhat parallel to that built around the settlement houses, workers alliances,

churches, and saloons in historical slums. Once these institutions started to build, they could achieve political power for slum communities and slum dwellers in a pattern again similar to the historical one. Such a concentration on creation of nodes could avoid the dilemma inherent in current programs which give the appearance of using Federal money for direct creation of local political power. By this much more indirect process, power would come, and it would probably be used in a coalition politics. This is in contrast to an attempt to build minority political power by a direct method which almost invariably engenders a majority coalescing against the minority. The suggestion here is that it doesn't make much difference what community action does in terms of delivery of specific services to the poor – with the funds available, it can't do much anyhow – but rather that the process of community action is itself the important one. It approaches the community action process in terms other than that which confuses the instrument and the ultimate objective and says "let's go out and organize the poor." At the same time, it gets away from the comprehensive community planning approach, which has not yet worked and, given the resources and competence available, is not likely to. Comprehensive community planning should be judged as to whether it provides an adequate means of building nodes, not as to whether the planning is adequate. It's not and it's not likely to be.

C.3. *Legal programs,* by setting precedents and by giving the poor a sense of their rights, will also fit well into such a program.

C.4. *Health programs for the poor* would be created around the same sort of center concept, by creating incentives for doctors, nurses, technicians, etc., to enter the center. Again, we should not worry too much about using money incentives to attain the desirable purpose.

C.5. *Family planning programs,* making information and devices available to whowever may want or need them, are also important and also require little administration. What requires administration in the family planning area is the detailed investigation of individual eligibility for help. Since the entire thrust of this overall program is to get away from setting one thing as a condition for another thing in an interlocking and unworkable system, family planning should be removed from the stigma of anything enforced on someone not wanting it. It should just be available.

D. In the *income maintenance* field, the corresponding part of the program would be a general non-categorical incentive-encouraging negative income tax built on a simple affidavit income test. This may be the single most important part of the package. For half of more poor families, work opportunity has little meaning. The family head is aged or disabled or a woman with a large family, or suffers from other disabilities. Yet a simple system of income maintenance for these families can mean opportunity for their children. The same is true for the children of families of the working poor. Money helps, it helps a lot. But current public assistance systems are spotty nation-wide, cover only a quarter of the poor, and discourage work incentives by taking away a dollar of assistance for a dollar earned. They represent the worst in highly administered systems, from the investigation of the "man in the house," to the social worker's decision about whether the family should buy a new blanket, to the forced imposition of "social services" on those who may need only money. The current welfare system perpetuates poverty and perpetuates itself. What is needed is a national income maintenance system – a system which covers all the poor, one which works by simple affidavit (enforced, as are the income tax laws, by exception), which separates services from income maintenance. The negative income tax is a version of such a system which has the major advantage of encouraging work and thus encouraging its own end by "taxing" away less than a dollar of income maintenance for a dollar earned. Working through the tax system or the Social Security System, it could substitute rules for administration and simplicity for intense and insane complexity.

To sum up, it seems to me that this overall package could take care of the needs of the poor and get at the basic causes of poverty while decreasing substantially the difficulties consequent upon imperfect administration in an imperfect world.

What is suggested is a "liberal" program in that it sets as the objective evolution toward a major and radical social change – the end of poverty. But it is a very "conservative" program in that it does this by working through incentives in the market place and by avoiding as much as possible detailed administration. It is my own feeling that not only for the War on Poverty but for the Great Society in general we will have to come to grips with this problem. The great advances of objectives in the Johnson and Kennedy administrations have not been accompanied by equally great advances in the numbers of people to achieve these objectives. From 1933 to 1940, the social needs of this country were so great that almost any program could prove effective. From 1940 to 1960 there were few new social programs anyhow, but the general progress of the economy achieved most of the social goals of the time without hardly trying at all. In 1960 and 1964 the country resolved to clean up many of the residual social problems left over in a prosperous economy. In 1966, the country reacted against the difficulties inherent in the administration of such programs. Perhaps now we can continue to move toward the same goals but do it in such a way which is more amenable to the desire of people to be left alone.

ADAPTIVE INSTITUTIONS FOR SHAPING THE FUTURE

by

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1. The Link between Planning and the Institutional Framework

Planning and institutions are mutually interdependent. A specific type of planning demands, and makes possible, specific types of institutions, and vice versa. The example of central planning at national level, as it is practised in Eastern countries, demonstrates the spectrum of institutions which are directly affected, although varying widely in their scope. Extending far beyond the institutions set up to elaborate plans, this spectrum also comprises the institutions set up to implement plans – as a matter of fact, most of the institutions carrying out tasks in relation to the needs of society. One may go further in stating that a specific type and " spirit " of the planning process correspond to a specific structure of or within society which, in turn, finds its expression in particular types of institutions.

If we take planning in the sense of *integrative planning*, cutting across a multitude of dimensions implicit in the interaction of Nature, man, society, and technology (1) – as well as factors and sub-categories such as economics and politics – the design of plans and of institutions has to be seen as an integral process, not as a parallel or consecutive process. Integrative planning is planning for change in a complex dynamic system, i.e. planning for a specific outcome, not just of action or elements (e.g. new technologies) leading to change. It includes measures to implement this change as well as to live with it subsequently in a systems framework. The *planning of institutions* of both types – for the realization of planned change, and for subsequent control – is an important aspect of integrative planning. This means, for example, that planning for technological innovation ought to include planning for new social institutions.

In a world characterised by evolution towards greater integration, the scope of planning has inevitably extended and with it the types of institutions required to design and operate plans. As a consequence, institutions with international and world scope are becoming mandatory today for many problem areas transgressing national or regional boundaries. Suffice it to name here the World Food Problem.

2. Institutional Requirements set by " Futures-Creative " Planning

Our perception of the evolving necessity to establish " futures-creative " planning (Ozbekhan) is still primarily intellectual and still basically lacking the

(1) See the author's paper on " Integrative Planning of Technology " in this volume.

realistic angle of view which could give us a clear concept of desirable institutional changes. Alas, this seems to be inherent in human thought. Throughout history, institutional change has seldom kept pace with the acquisition of new insight, but has taken place as a delayed response to increasing pressures (or even major crises and catastrophes) resulting from environmental change. It appears justified, therefore, to derive the institutional requirements from a planning model first, although the development of planning and the proper institutional framework is in reality an integral feedback process.

Our present situation can be diagnosed as the beginning of a major crisis, which is developing in a period measuring in years and decades rather than over the centuries, as in the history of mankind to date. However, for the first time, we can use long-range forecasting and planning as a tool to study the consequences of insufficient or delayed institutional change. We ought to use this newly acquired capability to apply spur, guidance and direction to change – even now it is too late to avoid the crisis, but it could still contribute to averting the catastrophe.

Looking at the evolving concept of " futures-creative " planning, we may readily recognize a few key characteristics which ought to determine the types of future institutions. " Future-creative " planning is, *inter alia* :

- *integrative*, implying the need for institutions to plan and operate on a " system-wide " basis (Ozbekhan). The " systems area " varies according to objective and handling capability, but planning for change in a complex dynamic system – as we described integrative planning above – must involve simulation on the basis of multivariate inputs. Characteristically, social, political, economic, and technological aspects of problems pertaining to the joint systems of society and technology must be dealt with.
- *normative*, implying the introduction of " a new kind of leadership indicating distant goals of such large significance that they dominate the trivial trends towards expansion for expansion's sake " (1). The leadership aspect is of crucial importance. Before we can apply comparative evaluation to prepare a rational choice, we need creative inputs at many levels. We need institutions to conceive of and study complete anticipations (2) and their functional elements, to devise alternative strategies – provide a rich " decision-agenda " (K. Boulding) – and to point out clearly consequences for the future as well as for the present. We need institutions to assess and forecast value dynamics, and institutions to establish and sharpen consensus where appropriate.

(1) René J. Dubos, Scientists Alone Can't Do the Job, Saturday Review, 2 December 1967.
(2) The term " anticipation " is used here in the meaning given by Ozbekhan, denoting intellectively contructed models of possible futures.

- *adaptive* (one may even say " cybernetic "), implying – for the medium- and long-range end of planning – the necessity for institutions relating continuously planning objectives and potentials to the changing environment, and to provide suitable information systems (1). However, capacity to adapt also requires a high degree of flexibility in the implementation of plans – implying, for complex problems, quite new and flexible types of institutional and inter-institutional pattern.

From an organisational angle, two important requirements should be pointed out which are partly implicit in the " spirit " and the mechanisms of the planning model summarized above. The " futures-creative " planning process should be :

- *democratic*, i.e. based on decentralised initiative and centralised synthesis (2), requiring effective communication to permit full understanding of corporate policies and objectives, and thus encourage self-motivation at all levels and stimulation and guidance of creativity.
- *not responsible for decision-making*, but providing rather the full information base for decision-making in a systematic manner. Planning aims at rationalization of the *basis for action*, and not at the rationalization of the action itself. This implies an institutional requirement for the interaction of planning and decision-making at the proper levels and at the proper decision points.

3. The Evolution Towards Adaptive Institutional Concepts

It is useful to look back for a moment at the changes in institutional concepts over the past few decades. This will help us to understand the changes which are now required, as evolutionary rather than revolutionary.

We may distinguish between three basic types : *instrumental*, *pragmatic*, and *adaptive* institutions. These types hardly ever appear in pure form, but as combinations in which one type dominates. A fourth approach is suggested today by the revival of the anarchist ideal of purely individual self-fulfilment in conjunction with the abolishment of institutions.

Instrumental institutions are primarily geared to the deployment of more or less rigid sets of material and immaterial resources for innovation (or conservation) and not to the innovation process as such. They may be regarded as semi-mechanical instruments capable of playing one tune only, but in different keys in the absence of well defined targets, and ignoring completely strategic alternatives. The tune is provided mainly by tradition. Instrumental Institutions preserve linearity of planning and action, are insufficiently sighted on future objectives and outcomes and attempt systemic consistency mainly with regard to quantitative problems of resource deployment, such as working out distribution rules for resource allocation against a background of traditionally established patterns of values, merits, and various diffuse " cultural " factors. In other words, instrumental institutions tend to apply a pseudo-rational " decisionistic model " which may be considerably influenced by the interaction of pressure groups. Frequently, instrumental institutions are characterised by the absence of planning altogether.

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(1) See the papers by Ithiel de Sola Pool and Theodore J. Rubin in this volume.

(2) The frequently applied notion of " group planning " seems to emanate from the same principle, but is perhaps not sufficiently precise.

The structure of instrumental institutions is usually horizontal and is defined in categories such as scientific and technical disciplines, skills, industries, armed services (Army, Navy, Air Force) and administrative entities. These categories refer back to the instruments themselves and tend to be captive to them ; they are incongruent with the categories applying to objectives and outcomes, and the systems they form ; therefore, they cannot deal with the quality of the outcomes. The structure of instrumental institutions is further characterised by a broad " budget-center " concept (1).

Examples of instrumental institutions in the public domain are Science and other Ministries, and National Science Councils. A clear case is the US National Science Foundation. Although much of the traditional scope of ministries or governmental departments and agencies belongs to the instrumental type, the insufficiency of this resource oriented rather than action- or target-oriented approach becomes particularly obvious in the institutions dealing with scientific and technological innovation.

In the military area, the initial and absurd " rocket race " between the different American armed services may be remembered, to which the introduction of the Planning-Programming-Budgeting System put an end.

In industry, the horizontally integrated hierarchic pyramid, still common in Europe, typifies the instrumental approach. It was appropriate for the 19th-century-type entrepreneur who planned, invented, and decided everything himself, and for his classical capitalist attitude, but cannot cope with the problem of rapid technological change faced by the big anonymous companies of today. Diversification policies based on the exploitation or deployment of material and immaterial resources (raw materials, special skills, etc.) also are typical for an instrumental industrial environment.

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(1) See the paper by Jay W. Forrester, " A New Corporate Design ", in this volume.

In higher education, finally, the inherited structure of the university and its traditional faculties may be called instrumental. However, the general cultural aspect of the original *universitas* (rarely manifest today in university curriculae) represents values at a higher level. The broad instrumental character of some of the fundamental research institutions, especially those in " big science ", has encouraged the fatal linking of fundamental research to higher education, and has thereby enforced the application of instrumental criteria to both areas.

Central planning, which, essentially, is usually little more than production scheduling and a quantitative economic calculus, may be considered as pushing the instrumental approach to the extreme. A number of qualitative refinements, introduced, for example, into the French National Plan, do however provide a certain flexibility of this concept.

Pragmatic institutions are geared to action leading to well-defined objectives, usually accepting a medium-range look into the future (as far as the " freezing " of such objectives permit). They are not, or are little concerned with defining the outcomes fo such action. In general, a recognized objective corresponds to a specific strategy. Pragmatic institutions may therefore be regarded as *ad hoc* arrangements for effective tactical (operational) planning and implementation. They become a problem when they tend to become permanent (as it is normally the case, encouraged by and contributing to society's inertia).

In technological innovation, pragmatic institutions are set up to develop specific and pre-defined technologies, acquiring and grouping resources in an optimized way. Pragmatic institutions have had spectacular success when applied to tasks of an interdisciplinary character, particularly in areas of advanced technology. Frequently, such interdisciplinary set-ups are referred to as " mission-oriented " institutions, which is not quite correct if there is no built-in flexibility to play with more than one strategic option (1).

(1) The broad mission-oriented institutions of the US Government, for example – primarily AEC (Atomic Energy Commission) and NASA (National Aeronautical and Space Administration) – exhibit both instrumental and pragmatic features (e.g. the Apollo program, handled in a highly pragmatic way), but in this combination already inclined towards the adaptive type, especially NASA.

Pragmatic institutions have been vehicles for the enormous acceleration of technological, and thereby social change in our time. But it cannot be denied that they are also, to a large extent, responsible for the dangerous divergent trends in the viable system on our planet. Pragmatic institutions tend to push certain strategies to their extremes, while neglecting alternative options. Like instrumental institutions, they function through linearity in planning and action — although deploying alternative sets of resources more flexibly than those ; they aim at quantitative, not qualitative targets. " Expansion for expansion's sake " finds a propitious framework in pragmatic institutions, as does the single-minded profit maximization motive, and the materialistic goals of the crude consumer society. They are the perfect expression of a " technocratic model " which currently dominates the free enterprise version of the economic system.

Lacking a clear view of the consequences of their work, pragmatic institutions are also primorally responsible for messing up the environmental system in which man has to live, in particular the joint systems of technology with man, society, and Nature. Moreover, they produce a certain distortion of social functions and objectives. The " polarization " of higher education to serve the needs of industry — today representing the most pragmatic institution of them all — is already becoming of major concern. There would be nothing wrong with such a " polarization ", if industry's role were to be seen in a wider social context — but this already leads towards a new type of adaptively organized industry, which is only beginning to emerge now. It is also in the framework of pragmatic industry that Galbraith's (1) warning of the dictate of the " technostructure " acquires real meaning.

The characteristic structure of a pragmatic institution is one of strong vertical " columns ", or even relatively independent " empires " with well-defined boundaries, thereby encouraging human ambition which is challenged by the prospect of power and individual success. The " budget-center " approach still prevails here, but on the narrow basis defined by such an " empire " ; from a corporate point of view, giving the vertically defined units financial responsibility, constitutes already a first step towards the " profit-center " concept.

Most of industry, especially in the United States, is today organized in the pragmatic institution form. Its primary characteristic is a structure composed of vertical product and service lines which are pushed to the extreme and "defended" against alternatives which might better satisfy simultaneous systems criteria. Non-organic diversification policies, leading to the so-called "conglomerates" grouping heterogeneous product and service lines mainly in order to build up financial power, may also be considered to belong here.

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(1) John K. Galbraith, The New Industrial State, Boston 1967.

Pragmatic governmental institutions have grown mainly in the military and space areas and have developed sophisticated forms of project management (1). However, it should be noted, that certain civilian parts of government also have pragmatic character, e.g. Ministries for Agriculture or Fisheries (rather than Ministries for Food Production and Supply), or Railroad Boards (instead of Ministries of Transportation, a trend which is now gaining ground).

In higher education, the prototype for the pragmatic approach is the modern Institute of Technology, with its technology-oriented departments, which have had striking success in newly developing interdisciplinary areas while, at the same time, permitting a deeper penetration into sharply defined scientific and technological diciplines (which may also be more or less pragmatically defined, such as aerodynamics, or microwave communications). The general aim of the pragmatic university or Institute of Technology is the generation of specialists. Specialists, in turn, generate sequential solutions which clog the systems with which man and society have to live.

As has already been said, the advance from instrumental to pragmatic institutions has been marked by spectacular success in the pursuit of pre-defined and sequential solutions, and of economic and other growth targets. Frequently, the conclusion is drawn that a change to pragmatic institutions is imperative, wherever instrumental institutions still dominate : setting up Applied Science Foundations and mission-oriented agencies, restructuring European industries and universities, etc. It would be fatal to follow this illusory promise of quick success, instead of aiming straight at new forms of adaptive institutions. It is already too late for detours.

Adaptive institutions are geared to the flexible process of continuous search and modification which is the essence of planning at the higher levels of "futures-creative" planning, namely the levels of strategies and policies. They may include pragmatically organized departments, or adaptive inter-institutional frameworks may be composed of " building blocks " which are, in themselves, pragmatic institutions. Tactical planning and action, aiming at well-defined and unambigous targets, will still benefit from a pragmatic approach, which, however, is embedded now in planning and decision-making processes dealing flexibly with a multitude of strategic and policy options. Adaptive institutions, or inter-institutional structures, permit the systematic consideration of high-level objectives which may be translated into a variety of tactical objectives (e.g. specific technologies, products, processes, or services) from which an operational objective is selected and " frozen in " only at a relatively late stage, immediately preceding action. Long-range forecasting and planning over a time scale of several decades can be practised in the fullest sense only within the framework of adaptive institutions. Here alone, the full mechanism of " futures-creative " planning can unfold in the interaction between policy, strategic, and tactical planning.

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(1) It is significant that, in the United States, the Pentagon-controlled laboratories are only now gradually changing from instrumental to pragmatic institutions, whereas military contract policies for industry have played a major role in sharpening the pragmatic concept in industry.

Adaptive institutions, in considering strategic and policy alternatives, are conducive to non-linear planning and action. In particular, they will select from a wide spectrum of feasible technologies by considering their outcomes in a systems context, for example a functional framework, and investigate the possibility of simultaneously satisfying a number of systems criteria. Thus, adaptive institutions have to be developed especially for integrative planning of technology (1). It becomes immediately clear that this complex task can often be undertaken effectively in multi-faceted inter-institutional frameworks rather than in single institutions. However, such inter-institutional frameworks must have a capacity for synthesis – in other words, a capacity for strategic and policy planning. It may be noted, that the intellectual separation of planning and decision-making (or of planning and action) may find its expression here in a visible geographical separation. Given the dimensions of the environment against which policies of institutions such as industry, research institutes, government departments, etc., have to be planned – frequently a global environment, or functional complexes of national or world scope – , it becomes obvious that common backgrounds for policies will be required in many cases for inter-institutional combinations. Strategic planning, on the other hand, will be more an affair of individual adaptive institutions.

The characteristic structure of adaptive institutions aims at a combination of powerful vertical impetus and subtle horizontal synthesis. Horizontal staff groups and planning units assume special importance. Their task requires a highly dynamic and flexible approach and may be compared to " translating " implications of objectives as well as feasible options vertically and horizontally in all directions. They are supposed to " animate ", to stimulate creativity throughout the entire structure, to collect and homogenize inputs, and to synthesize them into strategic and policy options. In short, they take care of one of the basic requirements derived in Chapter 2 above : the combination of decentralized initiative with centralized synthesis. Furthermore, the structure of adaptive institutions is geared to dynamic program management under stable or only slowly-changing functional headings. Adaptive institutions are conducive to the introduction of the " profit-center " concept (1).

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(1) See the author's paper on " Integrative Planning of Technology " in this volume.

The evolutionary trend towards adaptive institutions is already visible in all areas where the incentive to establish long-range forecasting and planning has been recognized. The Planning-Programming-Budgeting System (PPBS) (2) has already become a successful planning framework for dynamic programs, subsummed under functional categories. After the experience with PPBS in the US Department of Defense, the US Government has initiated, in 1965, its introduction to the civilian branches of government. Whereas this would impart an adaptive institutional character to the US Government as a whole, the scope of traditional and originally instrumentally organized Government Departments – such as foreign policy, defense, commerce, agriculture, etc. – will inevitably resist program formulation in the proper functional categories. However, it can be noted that some of the newly established Government Departments – in the United States, for example, the Department of Transportation and the Department of Housing and Urban Development, and, in a way, also the planned merger of the Commerce and Labor Departments – are practically congruent with the functional planning categories. PPBS has also been successfully tried out at lower jurisdictional levels, such as states, counties and communities, and is also considered for international organizations.

The best-organized industrial companies, working in areas of rapid technological change, are already (3) developing structures and management schemes leading to a degree of intra-institutional adaptivity, such as flexible " innovation emphasis structures ", superimposed over the more or less rigid administrative and operational structures. PPBS is also considered for application in industrial contexts. However, the development of inter-institutional industrial frameworks for tasks requiring an adaptive approach, is as yet barely contemplated. Where it has been realized partly, is in the framework of complex government programs, such as the American space program under the leadership of NASA. There can be no doubt, however, that industry will have to develop the capability to plan, design, build, and perhaps even operate the big systems of the future – systems of transportation, communication, education, health, urban living, etc. – and that this challenge can only be met by a flexible inter-institutional response from industry as well as other planning, research, and operational institutions.

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(1) See the paper by Jay W. Forrester, " A New Corporate Design ", in this volume.

(2) See the paper by David Novick, and its annex by Alain C. Enthoven, in this volume.

(3) A.D. Chandler, Jr., in his excellent book " Strategy and Structure " (Garden City, New Jersey, 1966), places the beginning of the movement of American industry from pragmatic towards adaptive institutional forms into the 1920's, and its peak into the 1950's and 1960's. However, it should be noted that, whereas Chandler's Types I and II correspond precisely to instrumental and pragmatic institutional forms, his industrial Type III represents only a first step towards an adaptive institution.

In higher education, finally, the present trend towards inter-disciplinary pragmatic approaches, reflecting in present university structures, will have to be pushed much further to functional, i.e. outcome-oriented, structures developing in congruence with the functions inherent in the joint systems of technology with Nature, man, and society, and other " bi-polar " sub-systems (1). In short, there will be a need for university departments such as " Environmental Health ", " Environmental Control (pollution, etc.) ", " Urban Development " (in the integral meaning implied in Doxiadis' term " ekistics ", comprising the elements Nature, man, society, shell, networks), " Integral Transportation Systems ", etc. Above all, there is need for a university structure capable of teaching the planning, design, building, and operation of systems in an integral way. Instead of being taught scientific or technological disciplines, or special skills, the student of the future ought to learn how to build good, " livable " systems, how to use a wide spectrum of scientific and technological possibilities to improve the quality of life and how to cope with the requirements integrative planning imposes on systems development. The primary aim of education will be to produce systems engineers in the broadest meaning of the word. They ought, for example, to deal integrally with the whole chain from product development to waste disposal or recycling of the waste. Today, the students of systems engineering may learn how to build complex technological systems, such as weapons systems – a very narrow-minded approach compared with the criteria to be satisfied in viable systems, such as joint systems of society and technology. The task is not only the frequently cited marriage of the natural and social sciences, but the reformulation of the entire university curriculum in the light of the systems sciences. H.G. Stever (2) sees this tremendous and complex task leading to a transitory crisis period for the university which has developed its excellence by penetrating deeply into sharply defined, independent disciplines, i.e. as an instrumental and, more recently, a pragmatic institution.

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(1) See the author's paper " Integrative Planning of Technology " in this volume.

(2) H. Guyford Stever, Trends of Research in Universities, in : Proceedings of the Symposium on National R & D for the 1970's, National Security Industrial Association, Washington, D.C., 1967.

It may be noted here that H. Marcuse's now famous " one-dimensional man " would only be free to move between the two extremes of being organized in a society with pragmatic institutions – the " repressive " civilization enforcing the principle of individual efficiency in the service of social goals, which overshadow individual goals – and a " non-repressive ", essentially anarchist society which would dispense with institutions (except those providing the material needs of man). In this view, the one-dimensional spectrum of possibilities would range from the supremacy of society and civilization (and the " repression " of individual goals) to the supremacy of the individual (and, consequently, the " repression " of social goals and the concerns of mankind as a whole). If, at the one extreme, the synergistic effect of society and civilization is led *ad absurdum* by lack of creative inputs, the negation of the psycho-social evolution of mankind and its reduction to the sum of individual creative acts (which are seen as the expression of man's *eros*), which we find at the other extreme, leads straight into the abyss of uncontrolled development and the catastrophes which can be readily forecast – in other words, to complete loss of human freedom.

Adaptive institutions, along with the integrative, normative, and adaptive character of " futures-creative " planning, provide a genuine alternative to this one-dimensional dilemma – one may say, they add a new dimension to the application of human creativity and freedom.

4. Problems of Intra-Institutional Adaptivity (1)

In considering the creation of adaptive institutional frameworks, at least two basic steps may be distinguished :

(a) The superposition of a flexible " innovation emphasis structure " (as one of the leading American electronics companies calls its innovation planning scheme) over a more rigid administrative and operations structure ; and

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(1) Chapters 4 and 5 are adapted from the author's paper " Technological Forecasting for Planning and Institutional Implications ", in the Proceedings of the Symposium on National R & D for the 1970's, National Security Industrial Association, Washington, D.C., 1967.

(b) Bringing the planning and operations structures to full congruence, or even identity.

There are good reasons for believing that for many tasks of technological and social innovation, taking just the first step and stopping short of the second will be the better solution for quite some time to come. Today, the *avant-garde* of planning at both the national and the industrial level is generally in the process of taking or consolidating step (a). The function-oriented PPBS is superimposed over the traditional service structure Army – Navy (plus Marine Corps) – Air Force within the US Department of Defense (1) and over the mainly traditional structure of departments and agencies of the US civilian government.

In industry, one finds a wide range of " innovation emphasis structures ", from the complex " matrix management " and the flexible task-force approach (which has become very fruitful in " strategic " corporate-level research laboratories) to formal schemes of interaction between corporate planning and divisional operations, and a high-level split between responsibilities for the present and for the future. The Bell Telephone Laboratories' " Systems Engineering " concept represents perhaps the most elaborate and highly sophisticated model for a flexible " innovation emphasis " approach against the background of a more or less stable discipline- and technology-oriented administrative and operations structure. The establishment of a strong " Corporate Development " function, comprising planning for innovation and corporate-level research and development, apart from " Operations ", represents advanced industrial strategic thinking aiming at an unobstructed view into the company's future (see Fig. 1).

At the level of technology, step (b) – congruence of planning and operations – may even become impossible, because the results of proper planning for strategic decision-making and for policies will require the utmost flexibility in the technological solutions selected for implementation. To reach this flexibility by continuously changing factory equipment and the tasks of design departments, is generally inconceivable at least at the stage of automation attained at present and attainable during the coming decade. However, the necessary degree of flexibility can be attained by changing combinations of resources " modules " – equipment, special skills, manpower, etc. – within a company, as it can be attained through inter-institutional combinations.

(1) However, the courageous attempt of the Canadian Armed Forces should be noted, which, with the introduction of a function-oriented planning structure in 1967, abolished the traditional service structure altogether.

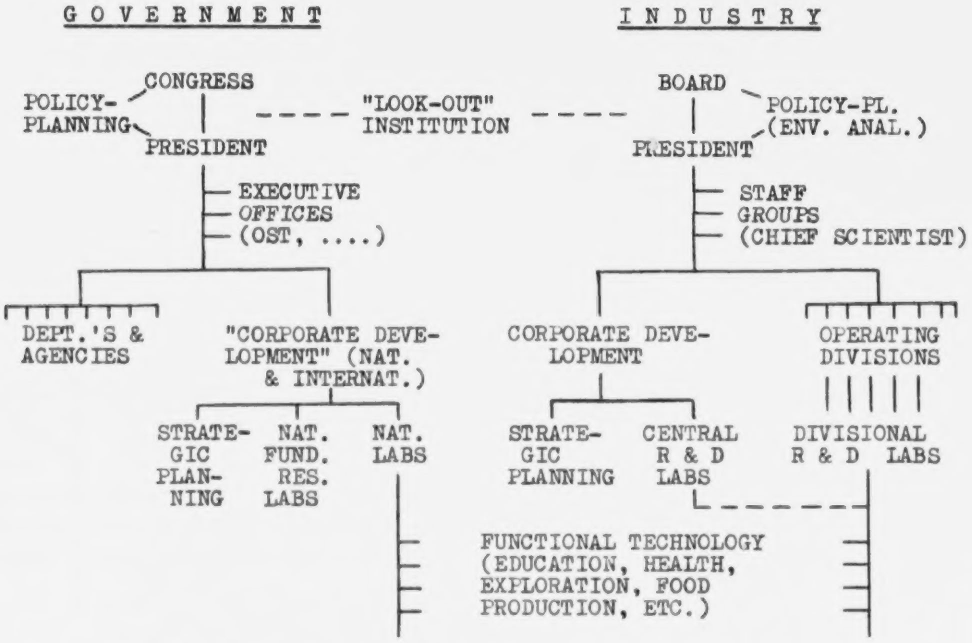
GOVERNMENT
INDUSTRY
CONGRESS
POLICY-PLANNING
PRESIDENT
"LOOK-OUT" INSTITUTION
BOARD
POLICY-PL. (ENV. ANAL.)
PRESIDENT
EXECUTIVE OFFICES (OST, ...)
STAFF GROUPS (CHIEF SCIENTIST)
DEPT.'S & AGENCIES
"CORPORATE DEVELOPMENT" (NAT. & INTERNAT.)
CORPORATE DEVELOPMENT
OPERATING DIVISIONS
STRATEGIC PLANNING
NAT. FUND. RES. LABS
NAT. LABS
STRATEGIC PLANNING
CENTRAL R & D LABS
DIVISIONAL R & D LABS
FUNCTIONAL TECHNOLOGY (EDUCATION, HEALTH, EXPLORATION, FOOD PRODUCTION, ETC.)

Figure 1. The developing analogy between structures for innovation in government and industry, demonstrated on a hypothetical example for the United States.

In considering adaptive institutions at the national level, one may believe in the development of a closer analogy between governmental and industrial structures. This analogy partly already holds for the present situation and, in the United States, corresponds to a conscious White House concept. For the purposes of full strategic and policy planning, it may be expected to develop further to a stage depicted in Fig. 1, in which a central agency for national and international " Corporate Development " will have the task of preparing technological and non-technological (e.g. social) innovation and carrying out research and development through function-oriented agencies and laboratories – analogous to an industrial " Corporate Development " structure. The principal difference would be that, in the government scheme, the applied research laboratories also would preferably fall under " Corporate Development " as long as the government departments and operating agencies do not yet represent a flexible function-oriented framework (as it can be established more readily for industrial operating divisions).

The scheme in Fig. 1 also implies a drastic change in the funding of governmental research and development. Not only will instrumental agencies, such as the National Science Foundation and the National Institutes of Health in the United States, no longer have a place in function-oriented planning and implementation, but also funding of research and development will no more go through the government departments – representing a rigid and only partly function-oriented structure that will deal with the task of " planning for society " in a fractionated way only – but through " Corporate Development " to which resources would be allocated directly by Congress and the President (to take the American governmental structure). The planning groups under the same roof, concentrating on synthesizing technological and social aspects, may resemble the proposed " Presidential Advisory Staff on Scientific Information Management ". Fundamental research will also come under " Corporate Deveolpment " and be guided in a much more flexible way, emphasizing its relevance to national and international policies as well as to strategies and functions ; fundamental research maturing to a stage where it contributes to functions (" oceanography " to the " food production " and " exploration " functions, etc.) will be moved on to functional research.

To the extent to which government will not be able to match industrial planning and implementation, for example due to the failure to establish an adequate mechanism for innovation, government's role in " shaping the future " will be inferior to industry's role.

Whereas the institutional structures for innovation emphasis, as they are emerging now in industry, will be adopted by government, industrial structures will evolve from the authoritarian towards the constitutional form. One of the forthcoming changes pointed out by J.W. Forrester (1), is already discernible in outstanding companies, especially in the United States: namely the " modification of the primary objectives of the corporation away from the already diluted idea of existence primarily for profit to the stockholders and toward the concept of a society primarily devoted to the interests of its participants. " The impact of this evolution will be felt most dramatically on the technical and management levels (Galbraith's " technostructure "). The consequences in terms of the abolishment of the superior/subordinate relationship and the establishment of the " profit-center " concept at the level of the individual, elaborated by Forrester (1), will mark the attainment of high intra-institutional adaptivity.

Even higher degrees of " *fluidity* " at the level of the individual can be expected with advances in information technology and automation that are feasible before the end of the century (2) : self-adaptive inventory, production and organization control ; automated marketing through home-terminals ; interlinked data banks ; automation of office and institutional data handling ; regional and global education centers accessible through home-terminals ; automation of optimal benefit resource application decisions ; etc. The entrepreneur of the future, i.e. the individual with technical and management skill, may very well interact – through " profit centers " – not only with one organization, but with a multitude of organizations to which he is connected by means of his home-terminal. Thus, the pursuit of intra-institutional adaptivity leads to the dissolution of institutional boundaries and the ultimate consequence of adaptive " inter-institutional " combinations at the level of the individual. This was to be expected if we insist on decentralized initiative and on bringing out the creative energies at the level of the individual. Man constitutes the " atom " of institutional creativity.

5. Problems of Inter-Institutional Adaptivity

In restricting our considerations to the next decade, we may assume a certain continuity of fixed institutions – even if the form of their engagement changes and becomes more flexible. In the more distant future, some of these institutions may lose their identity completely or may give way to entirely different institutions.

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(1) See Jay W. Forrester's paper " A New Corporate Design " in this volume.

(2) Ozbekhan, Hasan, The Future of Automation, *Science Journal* (London), October 1967.

The only new institution whose creation appears inevitable if policy-planning is to be established at a national and international level, is the " look-out " institution (H. Ozbekhan), or the " Institute for the Future " (O. Helmer) (1). In Ozbekhan's words (2), the main function of a " look-out " institution will be " to conceive of possible futures ; to create standards of comparison between possible futures ; to define ways for getting at such possible futures by means of the physical, human, intellectual and political resources that the current situtation permits to estimate. "

Fig. 2 attempts to outline a possible " innovation emphasis structure " at national level, as it may be realistically expected to emerge in the 1970's, at least in the United States. It is not to be confused with a structure for financing and implementing the results of planning.

The outstanding feature of the 1970's will be the emergence of industry as a " planner for society " on an equal level with government. This will result partly from industry's leadership in planning and management skills, partly from the particularly close relationship between industry and society. The consumer activities of society are satisfied directly by the industry-operated process activities (3) – which give industry also the most favourable starting point to influence society's attitudes. It is significant that in the United States, in contrast to Europe, almost the full spectrum of connective activities – with the exception of road building – is also planned and operated by the process and service industry. If the private sector is responsible for the dramatic advances in the communications networks, and sets out to penetrate into city building, there is no reason to exclude it from regional development (4).

Recent global estimates within a twenty-year time-frame foresee that the current process of industrial concentration will result in approximately 600 or 700 industrial groups, most of them operating as transnational companies,

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(1) The first " Institute for the Future " in the meaning given by O. Helmer, is starting at Middletown, Connecticut, in the fall of 1968 under Helmer's direction.

(2) Ozbekhan, Hasan, The Idea of a " Look-Out " Institution, System Development Corporation, Santa Monica, California, March 1965.

(3) For a discussion of the different types of activity in society, see the paper by Theodore J. Rubin in this volume.

(4) It should be noted that, with urban development having already entered the stages of " metropolis " and " megalopolis " (e.g. in the American North-East corridor, or the Great Lakes region), a vacuum between community and national administration is felt particularly in the development of networks.– On the other hand, American industrial companies have already become active in economic and general development planning on a national and regional level (e.g. Algeria, Sudan, Crete, and the West Peloponnese, etc.).

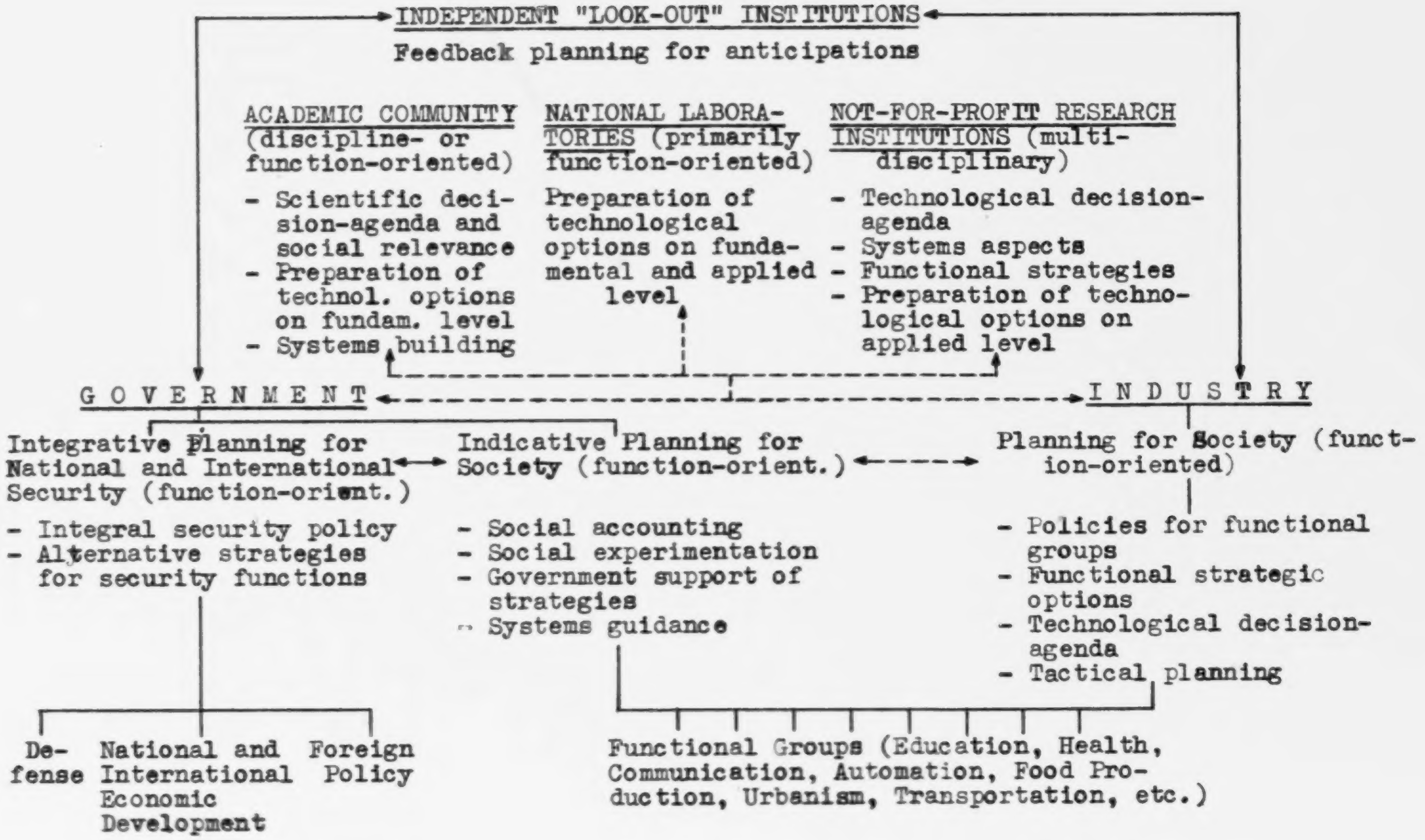
INDEPENDENT "LOOK-OUT" INSTITUTIONS
Feedback planning for anticipations
ACADEMIC COMMUNITY (discipline- or function-oriented)
- Scientific decision-agenda and social relevance
- Preparation of technol. options on fundam. level
- Systems building
NATIONAL LABORATORIES (primarily function-oriented)
Preparation of technological options on fundamental and applied level
NOT-FOR-PROFIT RESEARCH INSTITUTIONS (multi-disciplinary)
- Technological decision-agenda
- Systems aspects
- Functional strategies
- Preparation of technological options on applied level
GOVERNMENT
INDUSTRY
Integrative Planning for National and International Security (function-orient.)
- Integral security policy
- Alternative strategies for security functions
Indicative Planning for Society (function-orient.)
- Social accounting
- Social experimentation
- Government support of strategies
- Systems guidance
Planning for Society (function-oriented)
- Policies for functional groups
- Functional strategic options
- Technological decision-agenda
- Tactical planning
Defense
National and International Economic Development
Foreign Policy
Functional Groups (Education, Health, Communication, Automation, Food Production, Urbanism, Transportation, etc.)

Figure 2. A Possible "Innovation Emphasis Structure" at National Level. Only the principal lines of interaction are indicated. (This "emphasis structure" must not be confused with structures for financing and operating R & D programs, which will look quite different).

which will act as prime contractors for complex technological developments and sub-contract to a large number of small specialized firms. These 600 or 700 industrial groups can be expected to form the creative basis not only for providing technological contributions to social functions, but also for the planning, design, building and operation of joint systems between technology and man, or Nature. They will participate in, or lead, flexible and adaptive inter-industry structures – consortia, joint ventures, prime-contractor/sub-contractor patterns, flexible groupings of industry together with national laboratories and not-for-profit research institutions, and flexibly engaged discipline-oriented institutions (e.g. in academic and other fundamental research). The success, and added stimulation, reached by the engagement of some 20 000 or more industrial companies for NASA's projects in the US, already seem to prove the feasibility and the value of such an approach.

The overall national planning scheme, as suggested in Fig. 2, rests on the two " pillars ", government and industry, both of which concentrate their planning on those areas where their power of subsequent implementation is greatest – government on national and international security and industry on the joint systems which society forms with technology. Governmental planning for security, currently done piecemeal, should become an integrated exercise between, if we take the United States Government as an example, the White House/Department of Defense/State Department triangle, with inputs from departments and agencies concerned with economic development and aid, trade, and monetary discipline. Such integrated planning for security (including numerous cross-links with " planning for society ") will become even more important when the global crisis due to the population explosion, the inability of the agricultural food production system to cope with the rising food demand, the widening " gap " between the rich and the poor countries, etc., will reach much larger dimensions. The country that knows only how to defend itself but not how to manage the crisis (with technological developments providing effective means in many ways) and possibly avert a major catastrophe, may well be doomed before the end of the century.

The government's contribution to " planning for society " will be primarily of an indicative nature and concentrate on the augmentation and unification of industrial planning, for example through social accounting and social experimentation. But government will have a crucial role in bringing the plans for large systems to fruition, for example by creating new markets such as the recently proposed " pollution market ". Such new markets have been created in the past, for example, by the US Atomic Energy Commission (before civilian nuclear energy became an economic proposition) and by NASA. The planning and implementation of technological and social change through large systems will create new relationships between government and industry and change the modes and criteria of the economic system thoroughly.

In spite of the very close interaction to be expected between government's and industry's shares of planning, there must be an institution capable of integrating both and of thinking in terms of full-size anticipations (possible futures) : a *" look-out " institution*, possibly financed through government and industry, but acting independently. Its role in the scheme, according to Fig. 2, would not only be to construct and evaluate anticipations by putting together the planning pieces received from government and industry, but – much more important – to stimulate and orient planning by providing an " over-view ", and to ask the right questions by sub-contracting tentative planning tasks primarily concerned with alternative ways (strategies) to achieve specific anticipations. The powerful " alignment " of thinking through self-motivation which is experienced today wherever strategies and policies are formulated clearly (especially in industry), can be expected to repeat itself at a higher level if anticipations, and the ways to get there, can be spelled out clearly. However, the more difficult task of the " look-out " institution will be to keep the pattern of anticipations in a " fluid " state by operating a continuous intellectual feedback process.

It is difficult to imagine today, in a situation characterized by a strong polarization of all national systems aspects towards government and, to a lesser degree, towards industry, that the spiritual leadership in planning will be placed in a " brokerage institution " without executive power. Nevertheless, this appears to be a better solution than burdening the government with planning tasks beyond its horizon, and requiring an intellectual flexibility that cannot be maintained in close contact with decision-makers. Strategic planning by consulting " think groups ", exemplified in the United States by the RAND Corporation, has reportedly become a decisive success in defense planning. The recent decision, in the United States, to engage RAND, RAC (Research Analysis Corporation) and other consulting groups in the civilian area in connection with the introduction of the PPBS (Planning-Programming-Budgeting System), can be interpreted as a first step in the direction of establishing a planning scheme such as discussed here.

Another bold, but logical feature of the scheme according to Fig. 2 is the role of planning of the academic community (Academies of Science, universities, etc.), the national laboratories, and the not-for-profit research institutes : in planning, they are primarily interacting with the " look-out " institution, not with their financial sources government and industry. The establishement of a governmental " Corporate Development " function, as shown in Fig. 1, will facilitate the realization of such a concept, in particular in cutting the ties between national laboratories and government departments and ministries.

In the United States, the academic community has made a first step in the direction of participating in planning at national level, through the COSPUP (Committee for Science and Public Policy) of the National Academy of Sciences – and even for this very first step, there is no " climate of opinion " yet to be found in Europe.

It would be highly desirable if national schemes aiming at " planning for society " could soon be supplemented by *international schemes*. The existing international organisms are too inflexible to become part of an " innovation structure ". However, they might become instrumental in setting up suitable groups, such as an " international look-out institution of the advanced countries " which would first concentrate on planning for problems that can be solved only on a world-wide basis, such as the World Food Problem, population control, and environmental control (1).

It has been observed above that the development of the art of planning is pushing the development of institutions at present. The focus on systems planning – especially the integrative planning of joint systems of technology and society – will eventually change and mould institutions so as to give them the capability to gain an over-view over the system and synthesize possible ways of conceiving, building, and operating it. Clearly, the geographical and other systems boundaries frequently do not coincide with the institutional boundaries which our political systems recognize today : economic and defense blocs, nations, states, counties, and communities. The call for integral approaches to technological development on a European basis bears testimony to the dominating exigencies of technological change, which already overshadow traditional considerations of economic and defense agreements.

Political blocs, economic and defense blocs, nations, and communities may be regarded as pragmatic institutions pushing single-track concepts. With the cultural foundations of continents, nations, and regions vanishing in our

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(1) In 1967 and 1968, two such propositions were made – one with the support of the US Government, and one privately – but they have not got very far due to the inflexible political situation.

" technological era " and its trend towards unification – whether we like it or not – these pragmatic institutions will be gradually absorbed by, or subordinated to, new adaptive institutions which will take forms that will enable them to cope with the future systems aspects of our planet, especially with the joint systems between technology and society, and technology and Nature. Such new adaptive institutional frameworks, transgressing national and other traditional boundaries, will finally permit the overall problem of " ecological engineering " (1) to be tackled on regional and global bases.

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(1) See the author's paper on " Integrative Planning of Technology " in this volume.

Part Two

AFTER-THOUGHTS

Russell L. Ackoff

INSTITUTIONAL FUNCTIONS AND SOCIETAL NEEDS

The Bellagio Symposium placed a major emphasis on the need for planners to design new social institutions and organizations and to redesign old ones so that they become more responsive to their environment and the needs of those they serve. Hence, a great deal of attention was given to the form and structure of institutions and organizations, and to the informational and control systems required to operate them efficiently. It is apparent that there is not one form or structure that will serve all social functions equally well. In order to determine what form or structure is best suited to each function or combination of functions, we require classifications of both institutional forms and functions.

During the Symposium it became apparent that we do not yet have an adequate taxonomy of structure. We appear to be in a better position with regard to a taxonomy of functions. One such taxonomy was outlined during the conference, one which appeared to serve planning purposes reasonably well. Since this taxonomy does not appear in the papers prepared for the Symposium, I use this opportunity to add it to the record.

The classification of social functions that was discussed derives from an analysis of functions that are required to attain what might be called the *ideal society*. This society would be one within which every member could attain whatever he wanted with perfect efficiency, and in which he would always have an expanding set of desires. The first condition, perfect efficiency, could be vacuously filled by the elimination of all desire (i.e., Nirvana), but the second condition prevents this possibility. Man's ideal state is hardly a steady state; rather it is one that is dynamic and continually expanding in meaning and significance.

An analysis of the conditions necessary for the attainment of this ideal reveals the nature of required social functions. It also allows us either to identify the social institutions which perform them now, or to identify the functions which have not been institutionalized effectively.

In order to define these functions an important distinction must be made between *instruments* and *means:*

Instruments are *physical tools* that can be used by people in the pursuit of their objectives (e.g., such goods as hammers, computers, clothes, houses, etc.)

Means are *behavior patterns* of purposeful individuals (courses of action) which produce desired states (objectives).

Thus, for example, use of such instruments as hammers and nails is a means for joining two pieces of wood together and building a bookcase or a house.

Four very general functions are required for the pursuit of the ideal society :

1. The *Politico-Economic* Function: the pursuit of *Plenty.* To provide each individual with instruments that are perfectly efficient in the pursuit of his objectives.

2. The *Scientific* Function: The Pursuit of Knowledge or *Truth.*

   To develop the instruments and identify the means by which objectives can be obtained with maximum efficiency and to provide every individual with the ability to identify perfectly efficient instruments and means in the pursuit of his objectives.

3. The *Ethico-Moral* Function: the Pursuit of the *Good.*

   To remove conflict of objectives within individuals (i.e., to produce peace of mind), and conflict between individuals (i.e. to produce peace among men).

4. The *Aesthetic* Function: the Pursuit of the *Beautiful.*

   To enable every individual to enlarge the range of his objectives through the conceptualization of new desirable states.

Note that to the ancient triad - the *True,* the *Good* and the *Beautiful* – the modern ideal of *Plenty* has been added.

Each of these four general functions can now be furthur analyzed to reveal more specific functions for which social institutions and organizations have been developed.

1. *Politico-Economic Functions and Institutions.*

   1.1. To make available in some environment the instruments required in the pursuit of objectives. (This is the function of the institution of production which is embodied in such public and private organizations as departments of public works and industrial enterprises.)

   1.2. To place these instruments in locations to which individuals have access. (This is the institution of distribution which is embodied in wholesaling and retailing organizations and the transportation system).

   1.3. To provide individuals with access to the locations in which instruments are available. (Both the transportation and communication systems perform this function).

   1.4. To provide individuals with information about the availability and location of instruments. (This function is performed by advertizing, news services, and educational institutions. Relevant information is also provided by individuals, in particular, members of the family).

   1.5. To enable individuals to acquire instruments or the right to use them: to provide them with instruments for acquiring instruments (instruments of exchange, usually money).

   1.5.1. To enable individuals to provide for themselves by either exchanging their labor for money (through employment) or their money at one time for money at another time (through financial institutions).

   1.5.2. To provide instruments of exchange to individuals who cannot provide for themselves ; for example, the young, old, or incapacitated (through private institutions ; e.g., the family or charities, or public welfare institutions).

   1.6. To assure the individual of continued availability of instruments once acquired.

   1.6.1. Protection against appropriation by others in the same society (legal institutions including the police and the courts).

1.6.2. Protection against appropriation by others in different societies (military institutions).

1.6.3. Protection against accidental or natural damage (e.g.,fire departments and insurance, and, in the case of the human body, medical institutions).

1.6.4. Protection against wear or deterioration (maintenance services, and, in the case of the human body, medical institutions).

2. *Scientific Functions and Institutions*

2.1. To produce the knowledge necessary for development of new and more efficient instruments for more objectives. (This is the function of basic research which is carried out primarily by educational and research institutions.)

2.2. To use available knowledge to develop more efficient instruments for more objectives (applied research and development organizations).

2.3. To disseminate knowledge on how to use instruments which are available (the function of educational institutions).

3. *Ethico-Moral Functions and Institutions*

3.1. To remove conflict within individuals. (This has traditionally been a function of ethics as promulgated by religious institutions. More recently this function has been increasingly taken over by mental-health institutions which provide psychiatric services.)

3.2. To remove conflict between individuals. (Educational, religious, diplomatic, legal, and other institutions perform this function.)

4. *Aesthetic Functions and Institutions*

4.1. To "renew" man so that he is capable of striving for something better. (Continuous striving for improvement exhausts man both mentally and physically. In a state of exhaustion man can neither create new instruments nor conceive new means and objectives. It is necessary, therefore, to provide him with a "change of pace" in order to renew him, to recreate the creator. This is the function of recreational institutions. Sports and entertainment serve this purpose.)

4.2. To inspire man to create, to form new conceptions of the possible and to implement them. (Through beauty, art creates what might be thought of as the creative and heroic mood : a disposition to create, and the commitment to follow through. Art, religion, and philosophy have often painted pictures of what man and his world might become. The role of the leader is critical in this inspirational function.)

Evaluation of the progress of mankind with respect to the functions which have been identified yields two important conclusions:

1. Politico-economic and scientific progress has been great. The knowledge required to solve the problems of scarcity is well developed as are the institutions required to exploit this knowledge, at last in "advanced" societies. We are capable of eliminating poverty in principle, but not in practice. International and intranational distributions of wealth are uneven and, through conflict between and within nations, threaten to destroy much of the wealth that has been produced. In the process of gaining control over our environment we have produced an ecological imbalance which could, if extended, destroy wealth and those who can enjoy it. Much of the knowledge required to produce a desirable ecological balance is available, but is largely unused. Solution of the distribution and ecological problems is more a matter for the Ethico-Moral and Aesthetic institutions of society, than for the Politico-Economic and Scientific.

2. We have made little if any progress in the Ethico-Moral and Aesthetic domains. These functions were once almost completely embodied in the Church. But this institution, however well or poorly it performed, is no longer effective in these regards, particularly in those societies in which scarcity has been most effectively reduced. Governmental, educational, medical, and artistic institutions have failed to fill the widening gap. Plenty has brought with it the loss of both an intergrating social ethic and an inspiring aesthetic.

Therefore, the greatest problems facing the public and public planners in "developed" countries are the following:

1. To produce a more equitable international and intranational distribution of wealth.

2. To design and implement new institutional forms which can reduce or eliminate conflict between and within individuals, and thus to enable men to derive greater satisfaction from living together and with themselves.

3. To desing and implement new institutional forms which will produce the art and leadership that will give us new visions of the possible and the dedication needed to convert these visions into reality.

Stafford Beer

REFLECTIONS ON BELLAGIO

The working symposium made many impacts in detail on my thinking as would be expected. But I had one overriding reaction which may be worth recording.

I came to the peace and quiet of Bellagio in roughly the following state of mind.

The appearance of today's world is chaotic. A great mass of problems, ranging from urban growth to the world food shortage, from the control of city traffic through national economies to world population, are not being tackled scientifically. Perhaps they are not being tackled at all. Moreover, there are signs of incipient revolution in many parts of society in many countries of the world. However: because one is personally in the middle of the battle, it may all seem worse than it really is. Given a week for thoughtful reflection among like-minded colleagues, it seemed likely that all these matters would fall into a new perspective, passions die down, wise and tranquil judgments prevail.

These expectations were not fulfilled. At the end of the week I had come to a precisely contrary view. This I would describe as follows.

It is just because one is always in the middle of the battle that one too lightly accepts the chaotic conditions of today's world as normal. Moreover, the problems just mentioned as being in my mind at the start came into focus with a new and startling clarity. A child born this year may well live to see twenty thousand million people struggling for survival on this earth – ten times as many as were alive when I was a boy. This projection must influence one's thinking about every other major problem. What, for instance, would a city of sixty million inhabitants be like? As to the "incipient" revolution, the discussions compelled me to the conclusion that it is already with us.

Action is more urgent than I had supposed. Action is less likely to be taken than I had hoped. Although a few symposiants thought that there exists a ready ear for the major use of science in a sophisticated mode of planning, most of us thought not. All we could do was to prepare the Bellagio Declaration. It seemed better to do that than to do nothing, but it is not enough.

Jay W. Forrester

REFLECTIONS ON THE BELLAGIO CONFERENCE

No Definitions

The diversity of papers for this conference is understandable only if one realizes that no generally accepted definitions exist for the terms "long-range forecasting" and "planning". At the meeting efforts to define the terms failed. The inability to define planning resulted from the widely differing techniques and time horizons of interest to the members of the conference.

1. The time horizon important to some members was as short as three or four years. Several others focused on a thirty-year planning horizon and beyond.

2. In technique some saw planning as a decision-making process for allocating available resources to immediate tasks as exemplified by Novick in his paper on program budgeting. On the other hand, some saw planning as the design of a social system in terms of policies, laws, constitutional structure, and group and individual psychology to give that system the characteristics which are wanted. Such social system design is illustrated by the design of urban policies in my paper on complex social systems.

In the conference there was very little mention of forecasting. However, it seems clear that the task is not to forecast the future but to create the future. The challenge is to modify our social systems in a favorable rather than a detrimental direction.

Time Horizon

Because the time constants which govern social systems are so long, planning must look well beyond thirty years. Many trends that are starting today will not reach full maturity in less than 100 years. The foundations of modern technology were laid 100 years and more ago. Corresponding foundations for understanding, changing, and improving social systems are being laid in this century. How the emerging opportunities are used will determine the forthcoming 100 years. We cannot afford to look less far ahead.

Complex systems often show a short-term response to a change in governing policies which is opposite in direction from the long-term response. If we focus on the short run of one or two decades, we can be led into a series of actions each of which is favorable for a brief interval and each of which causes longer-term decline. It is such a series of policy changes, each addressed to the near future only, that leads to the decline of a civilization. Small steps each of which serves some purpose or prevents some difficulty can combine into a frustrating web which depresses individual initiative until the total system is lost.

If, as I believe, our social systems are counter-intuitive, then the short-term planning aimed at efficient economic allocation may be one of those processes which freezes and chokes the system so that it declines in the longer run. Planning for the near future will often conflict with planning for the more distant future.

The Planning Paradox

Why is it that our social systems:

1. Need planning
2. Do not accept planning
3. Are led into troubles of the kind that planning purports to alleviate.

Several reasons exist for this paradox.

First, planning has usually been effective only in the short run, if at all. Most planning criteria are derived from intuitive judgment, which will often be wrong because of the counter-intuitive nature of complex systems.

Furthermore, when planning appears to be effective it may at the same time be developing the conditions for longer-term degradation. This is likely as a result of the common reversal that occurs between the short-run and the long-run consequences of a policy change in a complex system.

Second, planning has often focused too much on the social system, often at the expense of the individual. The individual sees this and understandably resists planning.

Third, planning has often been directed, because of the failure to understand the dynamics of social systems, at control variables which are ineffective. Systems are often unresponsive to actions which appear directly to affect the desired consequences. Very often the influential control points are far removed from the place where the desirable results will appear.

Fourth, planning often aims at alleviating pressures within the system which should in fact be sustained and intensified. For example, in Figure 5 of my paper on complex social systems, the revived urban area with growing economic activity and a rising standard of living will generate pressures for additional housing. The rising economic activity provides the possibility of jobs for which there are no workers; the business managers will want more housing to attract more workers. The working population finds housing in short supply and will want it to increase. But the economic revival occurred because the excess housing of the slum area was reduced and the insufficient economic activity was allowed to increase. To reverse this process by encouraging housing instead of business can start the return to the decaying and blighted urban situation. In other words, every mode of operation of a system generates certain pressures. One must know what these pressures are. One must be willing to withstand and tolerate the pressures which must naturally accompany the behavior modes which are considered desirable.

Fifth, planning activity is often an end in itself. Planning is considered desirable. A planning group is established. The existence of the group discharges the obligation. The group is advisory; it does not contain people of great insight and stature. It is located far from positions of power, and even if its advice is sound there is little influence on decisions which are molded by political pressures.

Degree of Interlocking

The comment by Dr. King was most significant when he said, in citing the need for planning, that the problems are becoming greater than even any one government can influence. Is not this the difficulty at all levels in our social systems? Students feel that they are oppressed and ineffective because the university holds the power. But the university feels unable to act because it feels that power rests with the government. The employee feels entrapped and believes that the power rests with the corporation. But it is my personal observation that corporate managers often feel just as helpless and believe that the problems are greater than any one company can influence. But at the level of government the feeling is the same. The power must rest with other governments, or perhaps back within the social structure and the population of the country.

In fact, the purpose of planning must not be to solve the problem of how to make the entire system move together. To do so tightens the inflexibility and makes worse the feeling of futility. Instead, the objective of planning should be to design a satisfactory social system which, when viewed by the individual person, the institution, the company, or the political leadership of a country, leaves freedom of action at every point. Rather than increasing the degree of coordination one should be striving to sever the tightness of connections. This is the objective of my paper on a new corporate design printed in this volume. It is addressed specifically to the corporation. But in our industrial society the corporation is the working environment of most people. The spirit of the people, and the spirit of the country more and more tends to reflect the spirit of the working environment.

This relaxing of the tightness of interconnection was discussed in the conference in terms of the "invisible hand" concept of Adam Smith. The guidance by an invisible hand has become discredited, perhaps unjustly so. Even if the criticism of the economic system of the 1700's is fully justified one should strive to correct the deficiencies without eliminating the sense of individual freedom of action. The environment described by Adam Smith was not in reality an invisible hand. The guidance came from a legal structure and a body of social tradition. But when deficiencies in that system were observed, the corrections often did not follow good practice in social system design. Rather than altering the system to remove the causes of the trouble, restrictions were added to suppress the actions directly connected with the symptoms of difficulty. Often the original causes of the problems remained. After several hundred years these conflicting internal pressures begin to generate increasing stress. The stresses mount particularly rapidly when the fundamental assumptions underlying the old structural design begin to change. Much of our present legal and economic structure rests on the assumption of material scarcity. For much of the world that is still true, but for the industrialized countries with their entry into the "era of affluence" the declining importance of economic scarcity reduces the importance of the old structure. We are left without laws and traditions for a system in which economic activity is a background but the foreground is the quality of life and the emphasis of the individual.

Planning for the Future

There was at the conference no proposal for planning the design of a social system and its governing policies except through the use of computer simulation. A simulation model based on the feedback loop structure of a social system is the only method which shows promise of dealing with the necessary complexities. To explore the behavior of our social systems we must combine the economic, the political, the psychological, and the technological. The system must characterize not only the conditions of the society as a whole but must also deal with how that society appears to the individual. There was a time when perhaps the raising of the standard of living required the yielding of the individual to the good of the society and required favoring the future at the expense of the present. But the time is near when such methods will be neither necessary nor tolerable. It is time that we began an exploration of how our society is changing. The stresses from those changes are already beginning to appear. Their dynamic causes are not yet understood.

By combining the skills of the social sciences and the physical sciences and by re-uniting the many fragmented intellectual disciplines it is now possible, along with the simulation of dynamic behavior in complex systems, to begin creating understanding out of the present confusion.

The hope for designing better systems lies in the existence of key influence points in complex systems where a small number of actions will radiate a desirable effect throughout the system. Here the reader should note the exactly opposite opinions presented in the paper by Pool and in my paper on complex systems.

Pool says, "If we are right in characterizing not only present but future social theories as predominantly multi-variant simulations, lacking strongly dominant variables, then several important things follow. Predictions from such theories are highly dependent upon numerous empirical measurements. From the point of view of a person who controls any one variable, only a little can be predicted without entering large numbers of parametric measures on the other variables into his calculations. It is in the nature of things that the social sciences are data rich and theory poor. It is not just that we are at a primitive stage in them".

In my paper I say, "But a fourth characteristic of complex systems is a high sensitivity to a few parameters and a sensitivity to some changes in structure... There are a few points in any system to which behavior is sensitive. If these points are changed, they cause pressures to radiate throughout the system. Behavior everywhere seems to be different. But it is not because people have been persuaded or forced to act differently. It is because, responding in the old way to new information, they naturally take different actions. The parameters and structural changes to which a system is sensitive are usually not self evident, they must be discovered through careful examination of system dynamics."

In other words, I contend that the social sciences are "theory poor" only in the sense that the existing theories are wrong or inadequate. They are not theory poor in the sense that strong and powerful theories of behavior cannot and will not exist. The assumption of a large number of weak variables leads to massive data gathering with this data used in statistical models. But such models ignore the feedback structure of the system and cannot possibly lead to an adequate understanding of dynamic behavior. Starting from the other direction we can organize the kinds of structures and relationships which observation of the system components reveals. This leads to an entirely different conclusion about the importance of theory and data. My studies indicate that theory, that is, the proper system structure, is of the utmost importance. When structure and theory are handled properly, the design of an improved system becomes surprisingly insensitive to the numerical values of parameters.

Social Experiments

If planning of the design of social systems is to improve and to become effective, we must be able to distinguish good planning from bad. We must be able to determine which are the improved designs of social systems. Even in technological systems with their advantage of greater simplicity, we can never be sure of a design until it is tried. Oversights and defects are certain to appear. Improvements are necessary. Redesign is required. It is only through trial and experiment that technical improvement is possible.

But we do not have a tradition of accepting experiment in social systems. The reasons are not clear. Certainly it is not that we are so satisfied with our present systems that a search for improvement is unjustified.

Social experiment is handicapped by a tradition requiring equality for all persons. We are willing to try an experiment only if it is so persuasive that we shall apply it to an entire country. When an entire country must agree to an experiment we are restricted to those experiments which are intuitively appealing, but the counter-intuitive nature of social systems may make these the most dangerous and most undesirable experiments. We must develop the willingness to allow a city or any other political subdivision to operate as an experimental social system and where necessary to be exempt from certain specified laws of the country until the experiment can be evaluated.

Such an encouragement of experimentation was voted by the faculty of the Massachusetts Institute of Technology in 1962 in a faculty rule which reads as follows:

> " The committee shall . . . :
>
> 8. Encourage experimental innovation in undergraduate education with authority to approve limited educational experiments and to grant exceptions to allow any experiment to depart from specific Faculty Regulations and M.I.T. administrative procedures . . ."

This rule specifies a committee of about twelve members as the point of approval for any kind of educational experiment. The experiment can involve subject content, educational procedure, relationships between student and faculty, or any other condition affecting the environment and education of the student. The effect of this rule has been substantial. Many experiments have been approved. The existence of the rule has created the belief that change is possible and that attempts at improvement are worth the effort.

A way must be found to accept a similar concept on a broader scale. If social systems are to be designed it must be possible to test the designs without going through the process of political revolution.

Ecological Equilibrium

The conference met much of the time in separate groups. To me the highlight of the group I attended was the discussion of the dynamics and the condition of ecological equilibrium.

Traditional primitive societies lived equilibrium with their surroundings. Change, if it was occurring at all, was too slow to be perceptible. But for some four thousand years the condition of the human race has been characterized by growth and change. Literature has grown, population has increased, social organization has developed, geographical frontiers have been pushed back, and communication speeds have increased. These changes have been occurring as exponential growth rates, but no exponential growth rate can continue forever. If any exponential growth curve persisted, the entire universe would be engulfed. We are now in sight of the period when many of these exponential growth curves must level out into equilibrium. Population growth and pollution growth must cease. The growth of technology is losing its meaning because economic production has some intrinsic relationship to the physical ability of the human being to use and to consume. Clearly there is an upper limit to calorie intake. There is probably a corresponding though less well defined limit to other kinds of physical consumption.

We face then, in some countries sooner than others, the transition from growth to equilibrium. Figure 3b in my paper on complex social systems shows in the period between 75 years and 175 years how violent can be the shift of stresses in a system that is moving from growth to equilibrium. In that figure unemployment rises rapidly, the standard of living falls, obsolete structures begin to dominate, and tax rates rise. In a similar way we can expect violent changes in the internal relationships within our larger systems as those systems move from growth to equilibrium.

4

But the challenge is to determine the nature of that equilibrium. Will it be an equilibrium of poisoned lakes, of oppressive crowding, of food shortage, and a declining standard of living? Or shall we choose a different mode of equilibrium characterized by a more desirable set of conditions recognizing that those conditions will be associated with their own peculiar pressures which we must be willing to accept?

In this transition from growth to equilibrium, the entire goal structure of the civilization will change. The goals of ever increasing growth and expansion must be replaced by other goals. Here we need to think about the hierarchy of human needs as discussed by McGregor (1). He says, "Human needs are organized in a series of levels – a hierarchy of importance . . . A satisfied need is not a motivator of behavior! This is a fact of profound significance. . . . Consider your own need for air. Except as you are deprived of it, it has no appreciable motivating effect upon your behavior" MacGregor then goes on to list a sequence of five needs – physiological, safety, social, egoistic, and self-fulfilment. Through most of history, society has struggled to meet the essentials of the physiological and the safety needs. When unsatisfied these dominated behavior. The three higher needs exerted little influence. But now in the advanced technological societies the physiological and safety needs are widely met. Like air they tend to be taken for granted. But society has not learned how to turn to the higher needs and to use them for motivation and for setting goals. Is not much of the searching and frustration which we see today a lack of goals? Man has mastered technology and has used it in the more advanced countries to satisfy the physiological and safety needs. But from the standpoint of the society as a whole there is still uncertainty as to how to respond to the motivators that involve social, egoistic, and self-fulfilment needs.

Here is where the psychological, the organizational, and the technological meet. Only by designing systems in terms of the interactions of all these can planning serve the future.

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(1) McGregor, Douglas, *The Human Side of Enterprise,* McGraw-Hill, New York, 1960, pp. 36-39.

Dennis Gabor

REFLECTIONS ON THE BELLAGIO SYMPOSIUM

It has been said of the greatest of the Utopians, H.G. Wells, that he could break up any committee of four in half an hour, but he could never understand why the world would not adopt any of his Utopias, from ony day to another. By Wellsian standards we, the participants of the Bellagio Symposium, have behaved rather well.

But could we not have done better? I think we could have, if the planners had not so much insisted on improvising, but would have been willing to follow the well-laid plan of the symposium, discussing the papers and taking careful note of *all* the ideas which they contained. Of course the free discussion, which went on in one to three groups, gave an opportunity to those who had not written papers to air their views, but I wonder whether the gain outweighed the loss. Those who will read the papers can judge for themselves.

Taking the papers and the discussions together one can say that at least *one* important aim was achieved. We can now form a fairly good idea of the ways and means considered, practised or under investigation by a fairly comprehensive group of forecasters and planners in the Free World.

We had also a remarkable consensus of opinions on the main dangers which threaten our advanced civilisation: the decline of the Gospel of Work by the vanishing of the economies of scarcity, the antithesis between measures which lead to long-term improvements and those which satisfy the impatient expectations of the masses and force the hand of politicians, and above all the aimlessness and meaninglessness of a world in which rational thought, culminating in modern science and technology, has triumphed over the old enemies: poverty and insecurity – only to bring to the fore an even older enemy, the irrationality of Man.

There was fair argument between us that unless rational thought, guided by human values, can steer us into a new stable civilisation, the confused strivings of the young and the violence of other groups might easily evoke a backlash into authoritarian barbarism. There was less agreement on the ways how this could be best prevented. I could write a long list of urgent questions which have been left out of the discussions, but I want to mention only *one* problem which to me appears of supreme importance and of a nature fit for attack by the new planners.

Market Economics, now often known as "Capitalism", was so immensely successful because it made use of human self-interest. Like the patent system, in Abraham Lincoln's words, "it added the fuel of self-interest to the fire of genius". Lest an authoritarian system might appear as the only way out to the hard-pressed leaders who find themselves at the end of their wits, we must modify the social and economic structure so that there shall be a component of self-interest of individuals and corporations, pushing not in the direction of short-term gains, but towards long-term stability. Until by education we succeed in developing a higher social ethic, we must find ways for making projects, which now appear idealistic and unprofitable, *pay* in terms of money.

In the end we may develop a multidimensional value system, but in the age of transition we need social inventions which make use of the strong drive of material gain and direct it towards nobler ends – as sail and rudder allow a boat to sail against the wind instead of drifting with it.

Robert A. Levine

NOTES ON THE BELLAGIO SEMINAR

As is usually the case, what I came out of the Bellagio Seminar with is most closely dependent upon what I went in with. The following points – many of which are couched as *caveats* – are not for the most par very novel. The relevance of the seminar is that it left me convinced that the *caveats* need repeating in a document to be read by planners and users of planning.

Planning is a necessary and powerful device in guiding decisionmaking and in shaping the future. Like other necessary and powerful devices – modern drugs for example – it is also potentially very dangerous. It is dangerous if used unscrupulously but this *caveat* is not relevant to the Bellagio seminar.

The more relevant danger is that of the honest use of planning beyond the capability of this planning for producing meaningful results. In planning for public policy, the only field with which I have any familiarity, the easy observation is that the world is far richer than the models we build. And although simplification is part of the definition of modeling, we have not yet learned – nor do I think we are likely to learn – what can be simplified out without biasing the results in an unknown manner. For this reason, planning, including but not limited to model building, is important for its heuristics – for searching out hypotheses, relationships, branch points, points of sensitivity which are not obvious to the naked eye. But with rare exceptions planning and model building cannot substitute for the real world in testing these hypotheses and relationships.

Given this skepticism, then, the true importance of planning can be seen by contrasting it with what might be termed standard political decisionmaking, the king of decisionmaking which is described in volumes of history and pages of daily journals. Standard decisionmaking has been burdened by the difficulty of the human mind in keeping more than a few relevant factors at the fore of consciousness at one time. For example, decisionmaking on a matter of military policy must consider the effects of a policy on putative opponents, its effects on allies, its cost, its possible dangers of miscalculation, its effects on domestic politics, etc. Typically, such policy making has been dominated by one or two of these factors simply because the policy makers and their advisers could juggle only one or two at a time. This seems to have been the case, for example, in making up U.S. military policy in the 1950's.

The value of the plan is thus at least as a checklist. By laying the factors out sytematically, it reminds the decisionmaker that a policy must be considered on all counts simultaneously and that they must be weighted against one another. Indeed, it is not just a checklist but an n-dimensional checklist in which some fairly complex relationships of one factor to another can be laid out. This, really, is the essence of the McNamara revolution in military decisionmaking in the United States.

But having done this, the model *proves* nothing. It brings out relationships which might not have been obvious and it reminds the planner and the decisionmaker of factors which may have been subordinated and forgotten. But I would assert strongly that if results of a plan or model differ substantially from informed intuition about what the results should have been, the first thing to look for is what went wrong with the model. Or, more specifically, if the plan and the intuition differ, one had better be very sure that he understands why they differ in order to isolate crucial factors and to decide whether the difference is due to an artifact of the model or hidden relationships in the real world which were brought out by the model. My own bet is that in nine times out of ten it will be the model not the real world which has erred.

Closely related to this is the need to improve planning by recognition of the inexactitude of its results. Plans are never right in every detail, yet plans are frequently created and used on a basis which guarantees that they will work only if right in every respect. What is needed is a movement toward plans which are less sensitive to their own failure, plans which are pretty good even when some of the conditions are violated and some of the assumptions are changed. Too frequently have plans depended for their success on a precision which is impossible to obtain in human affairs. And lacking success they have not been merely less good but have in fact been spectacular failures. Urban renewal and slum clearance in the U.S. provides an example here. If myriads of local planners and program managers had responded as expected to the urban renewal laws which were supposed not merely to clear out slums but to rehouse slum dwellers, the programs could have changed the face of urban America. What turned out, however, was that the planners had made a slight miscalculation and the feasibility of breaking up and clearing out was much greater than the feasibility of putting back together and recreating homes and communities. Because the concept missed slightly, the effects were not merely less good than they might have been, the were very bad in terms of a variety of human miseries. What is needed is something flexible enough to correct its own errors as it goes along and to allow a missed assumption or calculation to mean no more than a somewhat less optimum result.

All that the above comes to, of course, is the old observation that "the best is the enemy of the good." This still has to be pointed out to planners and the users of planning.

Finally, because plans are unlikely to work as foreseen, what is most needed is a kind of planning which attempts to guide tendencies in desired social directions rather than to design precise machinery or well mapped roads to specific outcomes. The next big test for social planning is the design of systems which are likely to work in desired directions and are, as suggested above, relatively insensitive to their own failures. What is needed here and is not yet really available is a thorough understanding of incentives which in fact make individuals – decisionmakers at every level if you will – work in the desired social direction because they want to, not because some rule states that they have to (1). If rules and incentives oppose one another, rules become remarkably easy to get around. Much more must be known about incentive systems than now is known. In recognition of this fact and initial discussion of it, I found the Bellagio seminar most useful.

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(1) See my "Retninking our Social Strategies" in *The Public Interest*, Winter, 1968.

Aurelio Peccei

REFLECTIONS ON BELLAGIO

As it is always unwise for an amateur to tackle professionals, I think it would be improper for a non-specialist, as I am, to express his reflections on the Bellagio Conference with a view to adding something important to the concepts contained in this volume. In abstaining, I feel however comforted by the fact that the reader is already offered herein a torrential, high-quality flow of intellectual stimuli.

I may perhaps contribute, instead, to the appraisal and digestion of this bounty by people at large, by making a more general comment. Considering the broad terms of the theme, and what was said in the active give-and-take of opinions in our meetings, from the rather faraway vantage point of a manager – whose business is mainly that of deciding how ideas, facts and resources may be compounded into action, or preparation for action – any flaw or discrepancy of detail that the reader may perhaps find in these pages disappears, and the importance of the overall design pursued emerges instead. This is what I shall try to show in this brief note.

The search which went on at Bellagio, of course, is but a tiny moment of a long process, yet to be orchestrated at an appropriate scale, by which the potentials of planning will be explored and its techniques better defined, and then this new way proposed as a method for solving contemporary problems, the ever larger and more intricate problems confronting society in the coming decades.

The point I would like to make concerns the charge of radical innovation which is packed in the new conception of planning we are considering. The objective is to upgrade planning among human activities and give it the new dimensions of the long view and global scope. Now, apart from the uncommon effort required to get appreciable results along this line, it can easily be predicted that this conception itself will be strongly resisted – because of its truly revolutionary impact on the traditional conduct of human affairs.

I may say rather heretically that for me this trait represents one of the greatest values of long-range forecasting and planning, as I imagine it should be and, if I am not mistaken, as I saw it shaping up also in the minds of many participants at Bellagio. However, this view would probably look much less heretical, and perhaps become even somewhat conservative, if we could start by agreeing on a fundamental base for our forward reasoning, namely that we are going through a time of planetary emergency. The present state of disorganization of the world system, the uncontrolled forces we unleash against its compartmented structure, the exponential growth of interacting phenomena, many of them approaching critical maxima, the increasing gap between the new realities surrounding us and our understanding of these realities, all this complex of factors – unless we succeed in mastering the present influx and decide the future we want – is bound to bring civilization as we understand it, and possibly also mankind, to its gravest crisis and even to assured disaster in a not distant future.

Therefore, a radical change in our course and methods of managing the world (versus today's unmanagement-mismanagement) are clearly a very high priority at this juncture. And the "new" planning – which in substance is the purposeful, rational goal-oriented conducting of human activity – becomes an imperative necessity for survival and progress.

Viewed in this light, what the reader will find in this volume – and in only a few other similar exercises going on in Europe and the United States – has for me the immense value of bringing us to consider wholes components, the metasystem as a conditioner of all other systems embedded in it, macrosystems in preference to microsystems, the long-term continuum over the short-range, and the future as of equal hierarchy to the present, causes more important than symptoms, normative motivation over improvidence, and finality over expediency, the adaptive qualities of systems and institutions, hence dynamic stability, rather than existing stability, hence rigidity, or growth "per se" – in sum, a cybernetic approach and planning instead of piece-meal action, linear over-simplifications, and a "carpe-diem" outlook.

I am well aware that upholding this kind of planning may easily be criticized as a rather quixotic attempt to embrace the whole of reality, with its infinite complexities, using our present very poor assets and tools: a fragmented and uncoordinated information base, as yet unsystematized techniques, practically no government or popular support, and no personnel, either, trained for this kind of job. But, on the other hand, I am sure this is the only way in which men and women at this great turning point of history may force themselves to understand, however roughly, where they are and whence they may or can go, and to clarify the principles and values by which they wish to guide their everyday affairs and achieve their intellectual and moral fulfillment. And as planning, nay the functioning itself of society, requires centralized synthesis and decentralized, capillary "participation" – which implies that the entire arc of the decision-implementation process is structured on a continuum of feedbacks at the individual level – the exercise of progressively enacting the new planning will produce also this essential educational dividend.

I am also aware that the picture I have given above may be judged too gloomy. The rationale for the more optimistic, however, will not be very different. In fact, if we agree basically that a radical mutation in the relationships between man, society and environnent is underway, moving with quick strides — which may even purport the end, for good or ill, of a millenial cycle in the long history of human ascent — and that the outcome of our society and civilization will depend mostly on what we ourselves, and more generally the advanced nations of the world, do or do not do henceforth, then a new kind of planning is at all events necessary, to match the new thrust and threat and opportunities of change, and make the most out of them.

This is the great difference of Bellagio with respect not only to the great majority of other symposia and conferences which take place at an increasing tempo all over the place, but also to human thinking and activity prevailing throughout the world at this moment. And this reflection, properly expanded among the decision centers and cultivated public opinion, may well produce the support needed to continue and perfect the kind of work of which Bellagio is just a step, and finally to make operational this new approach and method to resolve the otherwise insoluble problems of the technological age.

Robert H. Rea

REFLECTIONS ON THE MEETING

The meeting was an experience of surprising contrasts. The one thing that most of the participants had in common was an interest in forecasting and planning methodology. Yet little time was spent in debating methods. There seemed to be larger issues, vaguely formulated, with which most people seemed compelled to grapple. The suggestion of a Manifesto was received with surprising unanimity by this group of entrepreneurs that could be expected to feel more comfortable defending small points. Our inability to formulate the issues clearly is shown by the statement produced – hardly a document that will stir men to action – but it is not for lack of trying. Progress was made to the point of expressing concern for something that was perceived as a "crisis" and expressing a sense of "urgency" for dramatic but carefully designed institutional change. Perhaps more specific action will be taken that would not have been were it not for the inspiration of the meeting.

A few methodological points were raised, seemingly out of a sense of responsability to the purpose of the meeting. It was intended that the papers be discussed, but since they had been read by all, there was insufficient patience for further discussion. Controversy still remains about Forrester's model of urban dynamics, but the following points that might ordinarily have stimulated much discussion, were dutifully stated and dropped:

1. Forecasting and planning are not yet accepted as possible, but there are many techniques that can be very helpful, if they are used with full knowledge of their limitations.
2. It is only a matter of time until forecasting and planning methods will be in such widespread use that competition will be in the form of a contest in the imposition of plans.
3. Although computer capacities and speeds are disappearing as constraints to planning models, it is inappropriate to get bogged-down in detail, since most planning problems can be described in terms of a few hundred variables.
4. Investments in forecasting and planning buy perceived confidence, time and efficiency.

5. Forecasts and long range plans should change continuously, and decision-making should be directed toward approaching but never quite reaching what is presently perceived to be the optimal situation.

6. Complexity and uncertainty are increased, not diminished through planning.

Instead of these points, much discussion was devoted to many different kinds of issues indicated by the following list:

1. Although improvements in forecasting and planning methods result in greater capabilities for centralization, it is imperative that the people "planned for" participate meaningfully in the process.

2. Planning functions in organizational design should be performed at the lowest possible level.

3. Multiple value systems should be accommodated within compatible hierarchies of goals. Dynamic stability of the hierarchy should be achieved by controlling rates of change of compatibility.

4. Planning should disseminate the opportunity to produce among islands of activities with spreading boundaries.

5. The failure to take aesthetics into account results in uninspired organizations.

6. In former times, well-defined value systems and religion provided a widely-understood social structure, but now everyone is responsible for his own values with little knowledge of those of others.

7. It is urgent that adaptive institutions be designed and used to accommodate the demands of social, economic, political, and technological change.

8. Widespread use should be made of major experiments, carefully designed for hypothesis building and testing.

Personally, I found the meeting quite stimulating, refreshingly free of academic polemics, with a substantial amount of capable and curious energy directed at attempts to define and offer approaches to solutions of difficult and elusive problems. The question remains as to what will be different from what it would have been without the meeting. I assume that no participant left without something new, and since most are men of considerable influence, many solution approaches may find their way into active experiments. Readers of the proceedings will find no recipes to solve their problems, but perhaps they will find the principles, philosophies, and statements of urgency sufficiently inspiring to take actions that they might have taken later, sooner.

Theodore J. Rubin

SOCIAL EXPERIMENTATION RECONSIDERED

There is little disagreement that, compared to previous times, most of today's societies are more complex, more interdependent, more densely populated, and more closely related in space and time. Many, but not enough, of the societies are more affluent than ever before. Many, too many, of them are conflictful in their internal and external behavior.

The stresses imposed within societies by the existence of these conditions importantly affect the attitudes, behavior and sense of belonging of all citizens. Those who by virtue of their age or social status have participated in the evolution of today's circumstances are inclined to view them favorably. Those who have not experienced past societal shortcomings for not having been born soon enough, plus those who for other reasons have been excluded from full social participation, are prone to a less favorable view. This view is variously manifested by personal hostility, disaffection, destructiveness, and distrust of the system.

What is obvious is that as time passes (and it passes more quickly now) and as changes propelled by technology occur (and they occur more frequently now), all, not just some, of a society's citizenry is affected. All institutions, organizations, and traditions which constitute the social structure are affected as well.

This situation does exist today, but it has always existed. In the past, however, hostility, disaffection, destructiveness, and distrust have remained within tolerable bounds in enlightened societies. Rates of technological innovation were low and the magnitudes of innovation more modest, providing time for human and institutional adaptation to or control of new circumstances. While we cannot return to the "good old days" – nor indeed would most of us want to – we can make an effort to find means to alter the rate of responsiveness of the social structure so as to return it to its stabilizing role in the further evolution of civilization.

The concept of *social experimentation* enjoys wide disrepute in the Western world. In part, this is because of the reported forms it has taken elsewhere in the contemporary world, and in part because of its jaded historical record. Social experimentation is generally construed to be synonymous with centralized control, that is, as imposed not participative, as restrictive not expansive, and as repressive not creative.

However, experimentation at its best has been *participative, expansive, and creative* in the practice of science. There seems to be no intrinsic reason why it cannot be so too, as a means for social innovation if two basic conditions are present.

First, self-experimentation must be accepted as a necessary, and, in fact, desirable function of social organisms. Just as industrial firms support and maintain research and development laboratories to invent, test, and evaluate new products, so must these same firms support and maintain an activity whose purpose is to invent, test, and evaluate new organizational forms for the enterprise. The purpose is not self-perpetuation of the organization so much as insuring timely responsiveness to a changing environment, that is, insuring the continuing relevance of the enterprise to both its clientele and to those whose combined energies make it work. The industrial analogy is indicative only. The concept of social experimentation may be similarly conceived for all manner of organizations and social institutions.

Second, the "self" in self-experimentation must be emphasized for the concept to prove participative, expansive, and creative. The subjects of experiments must participate in both their design and evaluation. The experiments must originate, be conducted and terminate within the target social organism. For example, an experimentation laboratory for the University of California at Berkeley must permit (or rather, encourage) continuous tinkering with the Berkeley system by Berkeley administrators, faculty, and students. Coupled to a means which insured that promising experimental results would be granted a full-scale test in the parent organism, such a function could prove a powerful force for channeling energies which are hostile, destructive, and distrustful today into creative, constructive paths tomorrow. While results of some experiments may be transferable across institutions (e.g., from Berkeley to Stanford) the intent of social experimentation should not be economy and social uniformity through transferability, but rather replication and social diversity through widespread participation.

It does not seem worthwhile at this time, and, in fact, it may not be at all relevant, to assess the costs and benefits of a widespread institutional policy of self-experimentation. Philosophically, the issue is one of finding constructive means to enhance the responsiveness of the social structure. The most important costs, both economic and social, are likely to be those of continuing to let change just happen.

The single most important message to be conveyed is that for the foreseeable future, the name of the game is the reposturing of the social structure so that it can once again get control of and direct technological progress. The concept of social self-experimentation with the fullest possible participation is a promising strategy for playing that game. Renaissance planning will assist by developing and supplying analytic tools to enhance this vital new societal activity.

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